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(71)出願人 000002185
 ソニー株式会社
 東京都品川区北品川6丁目7番35号

(72)発明者 石橋 義
 東京都品川区北品川6丁目7番35号 ソニ
 一株式会社内

(72)発明者 市村 真理
 東京都品川区北品川6丁目7番35号 ソニ
 一株式会社内

(74)代理人 100076059
 弁理士 逢坂 宏

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(54)【発明の名称】 有機電界発光素子

(57)【要約】

【課題】 高輝度かつ安定な赤色発光を有する有機電界発光素子を提供すること。

【解決手段】 発光領域を有する有機層5、5a又は5bの少なくとも1部に下記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物が含まれている有機電界発光素子。

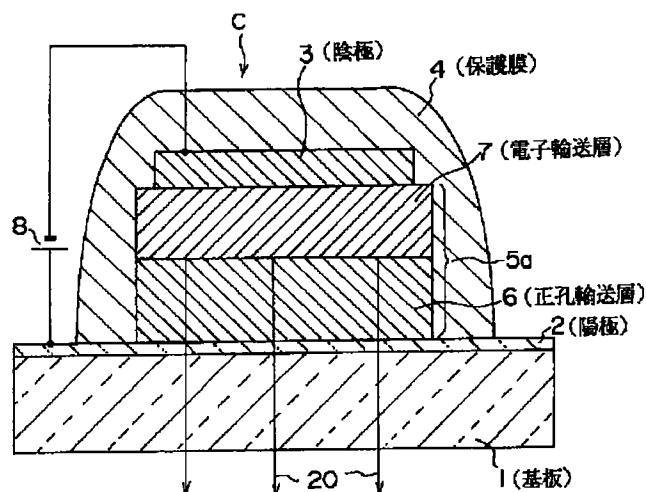
一般式[I] :

$Y^1\text{-CH=CH-X}^1\text{-CH=CH-Y}^2$

一般式[II] :

$Y^3\text{-CH=CH-X}^2$

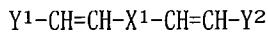
[但し、前記一般式において、 X^1 、 X^2 はアントラセン基等のアリール基、 Y^1 、 Y^2 、 Y^3 はアリールアミノ基などを表わす。]



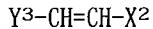
【特許請求の範囲】

【請求項1】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、下記一般式[I]又は[I']で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物からなることを特徴とする、有機電界発光素子。

一般式[I]：

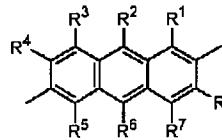


一般式[I']：

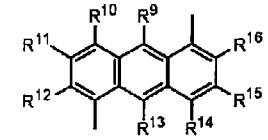


[但し、前記一般式[I]において、X¹は下記一般式(1)～(4)のいずれかで表される基であり、

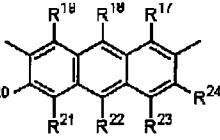
【化1】



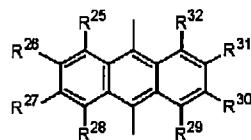
(1)



(2)



(3)



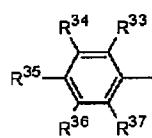
(4)

(但し、前記一般式(1)～(4)中のR¹～R⁸、R⁹～R¹⁶、R¹⁷～R²⁴、及びR²⁵～R³²のそれぞれにおいて、少なくとも一つがハロゲン原子、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であり、その他は水素原子、アルキル基、アリール基、アルコキシ基、ハロゲン原子、ニトロ基、シアノ基及びトリフルオロメチル基

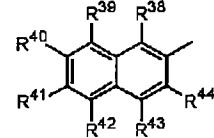
から選ばれた基である。また、それらが同一であっても異なっても良い。)

また、前記一般式[I']において、X²は下記一般式(5)～(17)のいずれかで表される基であり、

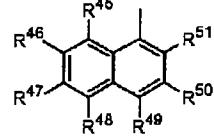
【化2】



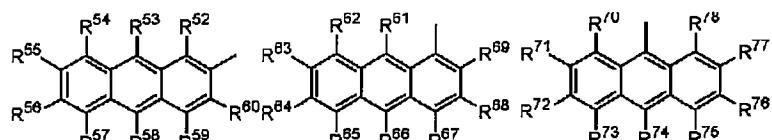
(5)



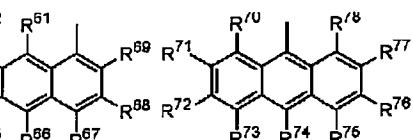
(6)



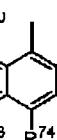
(7)



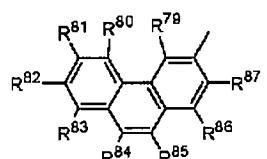
(8)



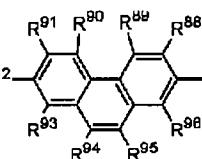
(9)



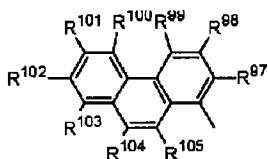
(10)



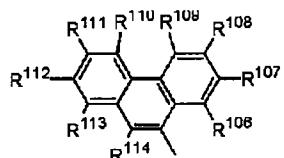
(11)



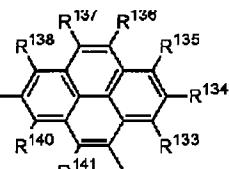
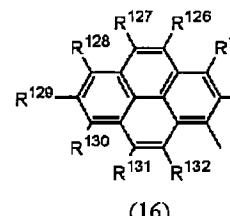
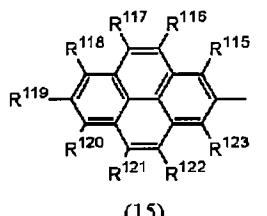
(12)



(13)



(14)

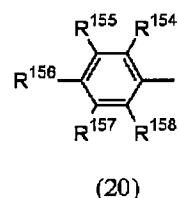
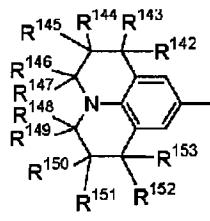
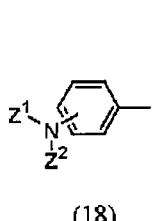


(但し、前記一般式(5)～(17)において、R³³～R¹⁴¹は水素原子、又はハロゲン原子、ニトロ基、シアノ基及びトリフルオロメチル基から選ばれた基であり、それらが同一であっても異なっても良い。)

また、前記一般式[I]及び[II]中のY¹、Y²及びY³は水素

原子、置換基を有しても良いアルキル基、又は下記一般式(18)～(20)のいずれかで表される置換基を有しても良いアリール基から選ばれた基であり、それらが同一であっても異なっても良い。

【化3】



(但し、前記一般式(18)中のZ¹及びZ²は水素原子、置換基を有しても良いアルキル基、又は置換基を有しても良いアリール基から選ばれた基であり、それらが同一であっても異なっても良い。また、前記一般式(19)及び(20)において、R¹⁴²～R¹⁵⁸は水素原子、置換基を有しても良いアルキル基、置換基を有しても良いアリール基、置換基を有しても良いアルコキシ基、ハロゲン原子、ニトロ基、シアノ基及びトリフルオロメチル基から選ばれた基であって、それらが同一であっても異なっても良い。)

【請求項2】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項1に記載の有機電界発光素子。

【請求項3】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記一般式

[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項1に記載の有機電界発光素子。

【請求項4】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項1に記載の有機電界発光素子。

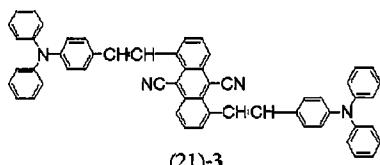
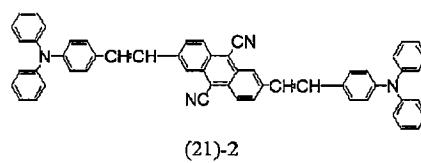
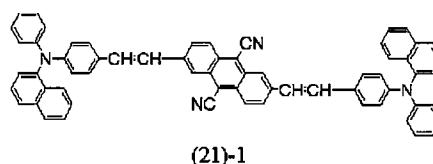
【請求項5】 前記有機層が、ホール輸送層と発光層と

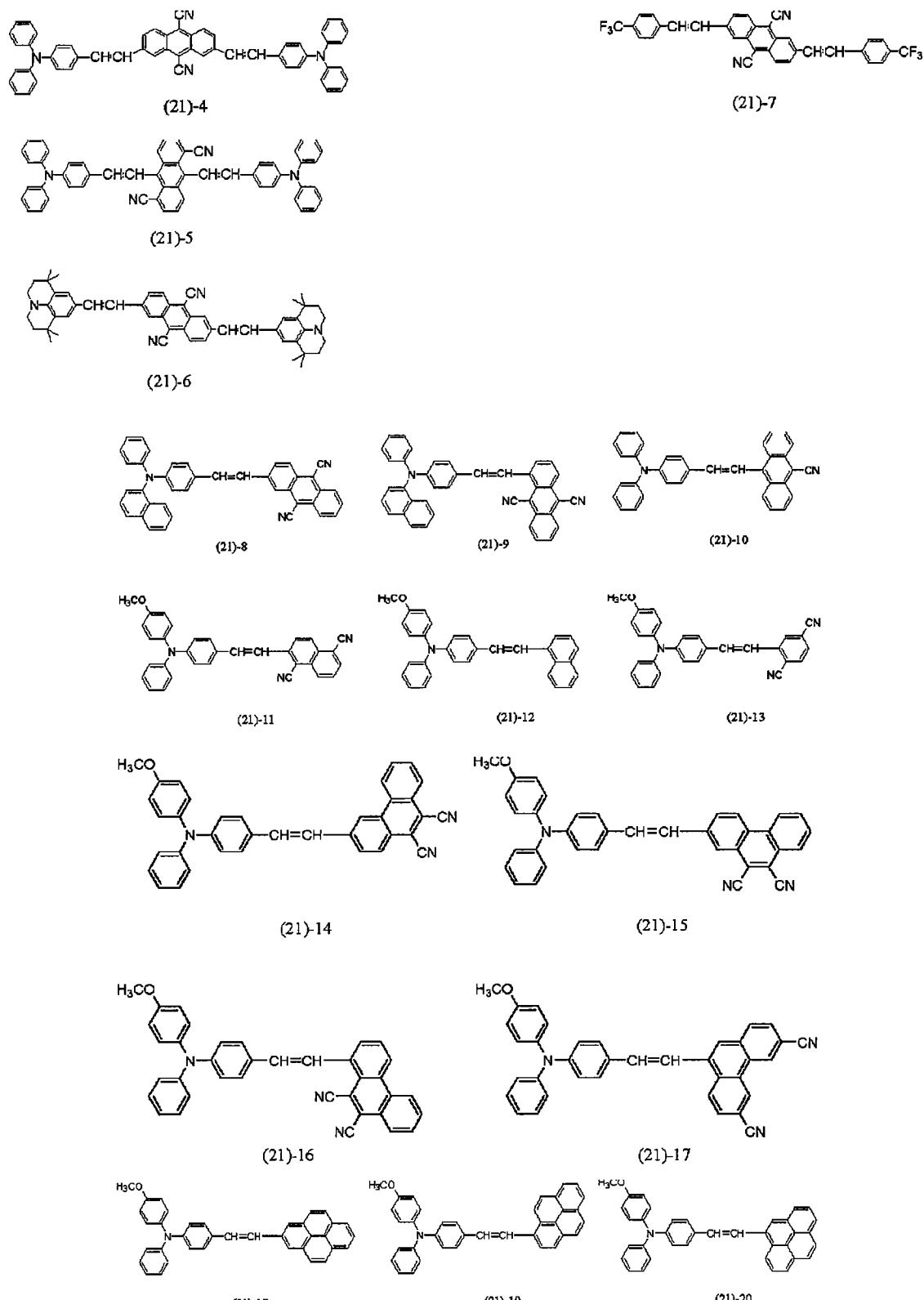
前記有機層のうちの少なくとも発光層が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項1に記載の有機電界発光素子。

【請求項6】 前記混合物における前記アミノスチリル化合物の割合が10～100重量%である、請求項1に記載の有機電界発光素子。

【請求項7】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、下記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物からなることを特徴とする、有機電界発光素子。

【化4】





【請求項8】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記構造式(2-1)～(2-1)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項7に記載の有機電界発光素子。

【請求項 9】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機

1) - 1 ~ (21) - 20 で示されるアミノスチリル化合物の少なくとも 1 種を含んだ混合物層である、請求項 7 に記載の有機電界発光素子。

【請求項 10】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記構

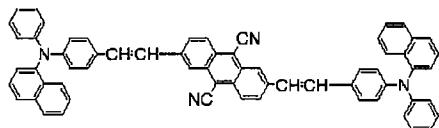
チリル化合物の少なくとも1種を含んだ混合物層である、請求項7に記載の有機電界発光素子。

【請求項11】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも発光層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項7に記載の有機電界発光素子。

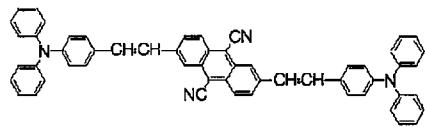
【請求項12】 前記混合物における前記アミノスチリル化合物の割合が10～100重量%である、請求項7に記載の有機電界発光素子。

【請求項13】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、下記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種と、600nm～700nmの範囲に発光極大を有する赤色発光色素とを含んだ混合物からなることを特徴とする、有機電界発光素子。

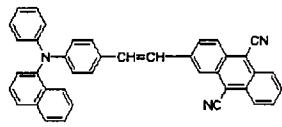
【化5】



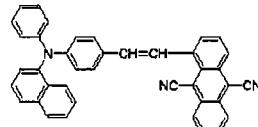
(21)-1



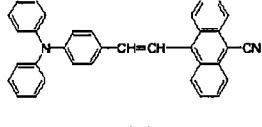
(21)-2



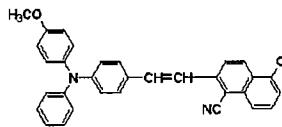
(21)-8



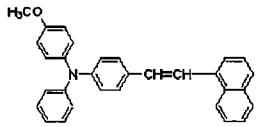
(21)-9



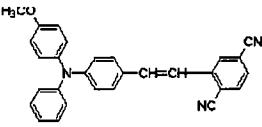
(21)-10



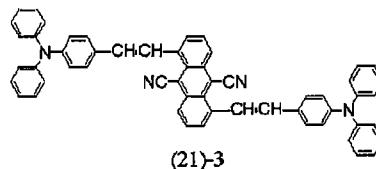
(21)-11



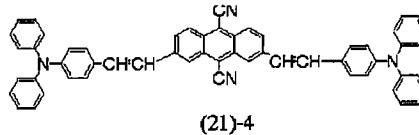
(21)-12



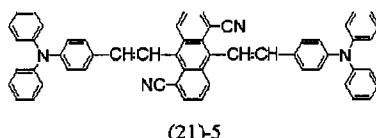
(21)-13



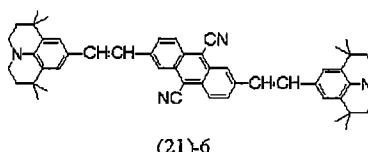
(21)-3



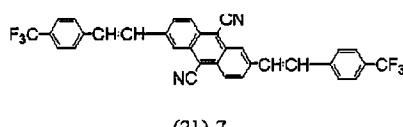
(21)-4



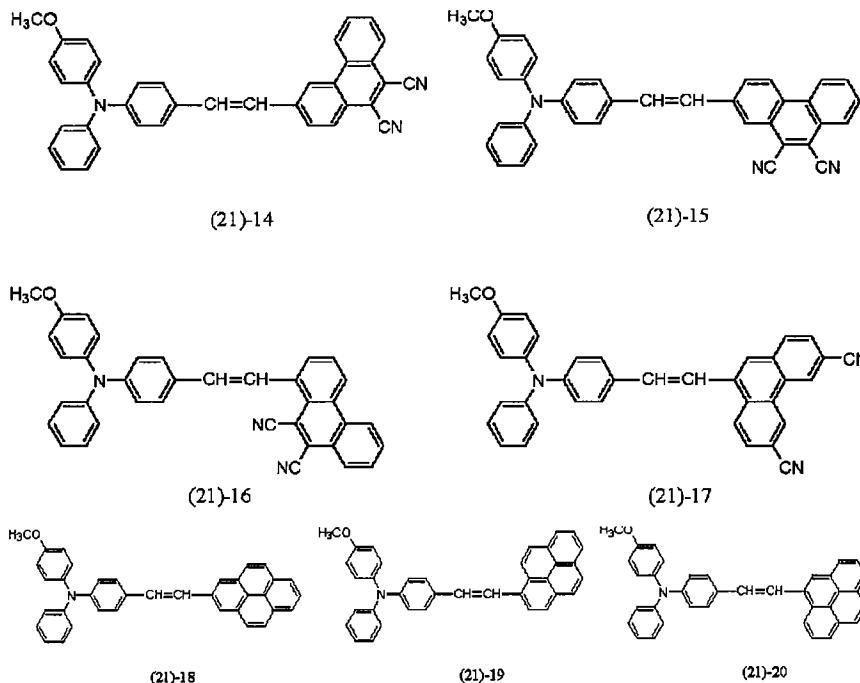
(21)-5



(21)-6



(21)-7



【請求項14】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項13に記載の有機電界発光素子。

【請求項15】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項13に記載の有機電界発光素子。

【請求項16】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項13に記載の有機電界発光素子。

【請求項17】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有してお

り、前記有機層のうちの少なくとも発光層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層である、請求項13に記載の有機電界発光素子。

【請求項18】 前記混合物における前記アミノスチリル化合物の割合が10～100重量%である、請求項13に記載の有機電界発光素子。

【請求項19】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、下記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物からなり、かつこの混合物で構成された層の陰極側に接してホールブロッキング層が存在することを特徴とする、有機電界発光素子。

一般式[I] :

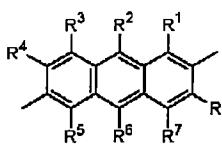
$Y^1-CH=CH-X^1-CH=CH-Y^2$

一般式[II] :

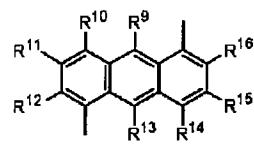
$Y^3-CH=CH-X^2$

[但し、前記一般式[I]において、 X^1 は下記一般式(1)～(4)のいずれかで表される基であり、

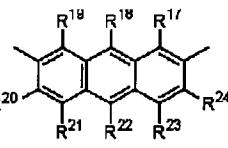
【化6】



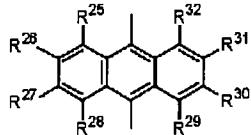
(1)



(2)



(3)

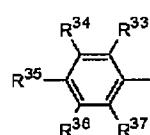


(4)

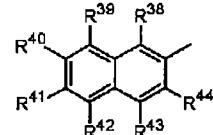
(但し、前記一般式(1)～(4)中のR¹～R⁸、R⁹～R¹⁶、R¹⁷～R²⁴、及びR²⁵～R³²のそれぞれにおいて、少なくとも一つがハロゲン原子、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であり、その他は水素原子、アルキル基、アリール基、アルコキシ基、ハロゲン原子、ニトロ基、シアノ基及びトリフルオロメチル基

から選ばれた基である。また、それらが同一であっても異なっても良い。)

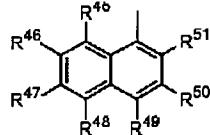
また、前記一般式[II]において、X²は下記一般式(5)～(17)のいずれかで表される基であり、
【化7】



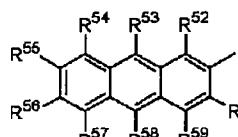
(5)



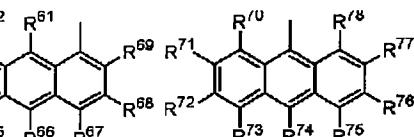
(6)



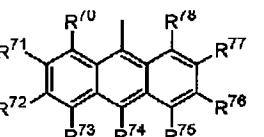
(7)



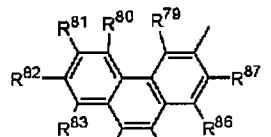
(8)



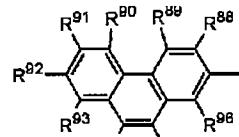
(9)



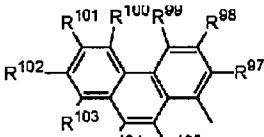
(10)



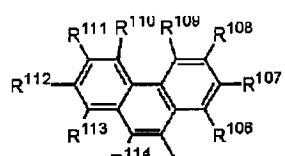
(11)



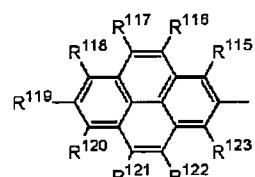
(12)



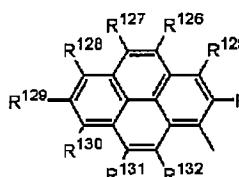
(13)



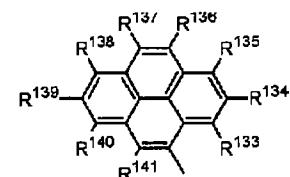
(14)



(15)



(16)



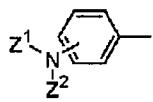
(17)

(但し、前記一般式(5)～(17)において、R³³～R¹⁴¹は水素原子、又はハロゲン原子、ニトロ基、シアノ

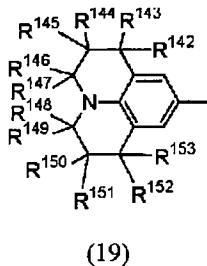
基、トリフルオロメチル基から選ばれた基である。また、それらが同一であっても異なっても良い。)

また、前記一般式[I]及び[II]中のY¹、Y²及びY³は水素

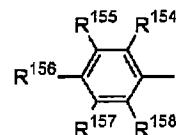
式(18)～(20)のいずれかで表される置換基を有しても良いアリール基から選ばれた基であり、それらが



(18)



(19)



(20)

(但し、前記一般式(18)中のZ¹及びZ²は水素原子、置換基を有しても良いアルキル基、又は置換基を有しても良いアリール基から選ばれた基であり、それらが同一であっても異なっても良い。また、前記一般式(19)及び(20)において、R¹⁴²～R¹⁵⁸は水素原子、置換基を有しても良いアルキル基、置換基を有しても良いアリール基、置換基を有しても良いアルコキシ基、ハロゲン原子、ニトロ基、シアノ基及びトリフルオロメチル基から選ばれた基であってそれらが同一であっても異なっても良い。)

【請求項20】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記一般式

[I] 又は [II] で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在する、請求項19に記載の有機電界発光素子。

【請求項21】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記一般式

[I] 又は [II] で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在する、請求項19に記載の有機電界発光素子。

【請求項22】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつこの電子輸送性発光層の陰極側に接して前記ホールブロッキング層が存在する、請求項19に記載の有機電界発光素子。

【請求項23】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも前記発光層が、前記一般式[I]または[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在する、請求項19に記載の有機電界発光素子。

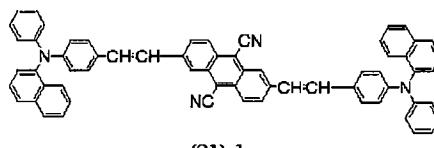
同一であっても異なっても良い。

【化8】

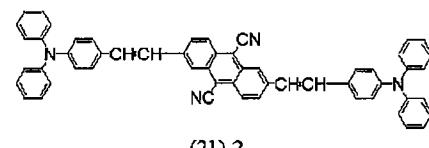
ル化合物の割合が10～100重量%である、請求項19に記載の有機電界発光素子。

【請求項25】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、下記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物からなり、かつこの混合物で構成された層の陰極側に接してホールブロッキング層が存在することを特徴とする、有機電界発光素子。

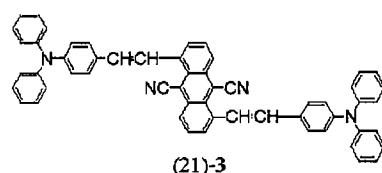
【化9】



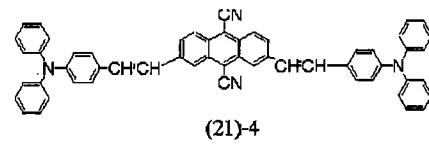
(21)-1



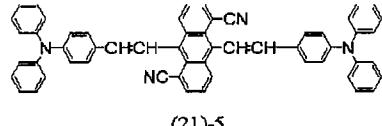
(21)-2



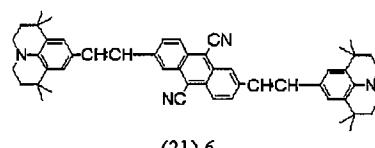
(21)-3



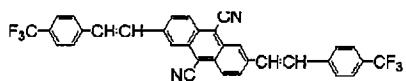
(21)-4



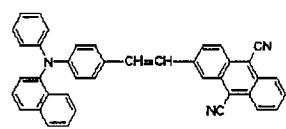
(21)-5



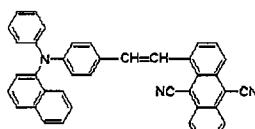
(21)-6



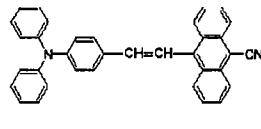
(21)-7



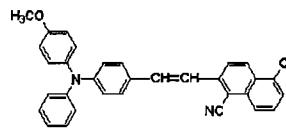
(21)-8



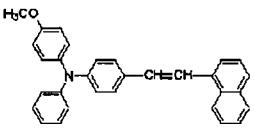
(21)-9



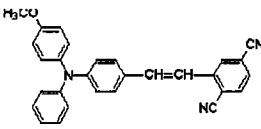
(21)-1



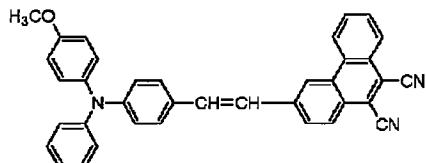
(21)-11



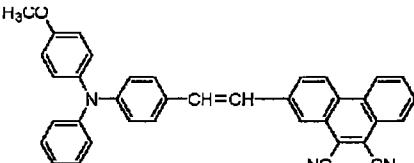
(21)-12



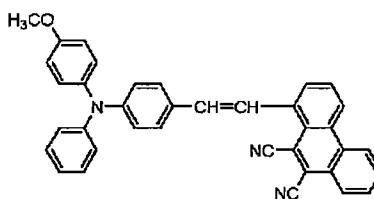
(21)-13



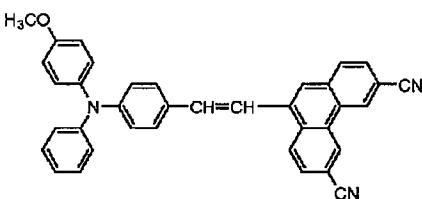
(21)-14



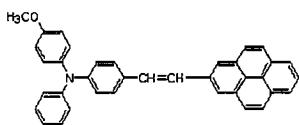
(21)-15



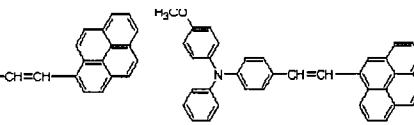
(21)-16



(21)-17



(21)-18



(21)-20

【請求項 26】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記構造式(21) - 1 ~ (21) - 20 で示されるアミノスチリル化合物の少なくとも 1 種を含んだ混合物層であり、かつ前記混合物層に接して陰極側に前記ホールブロッキング層が存在する、請求項 25 に記載の有機電界発光素子。

【請求項 27】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記構造式(21)－1～(21)－20で示されるアミノスチル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層に接して陰極側に前記ホールブロッキング層が存在する、請求項25に記載の有機電界発光素子。

【請求項28】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホ

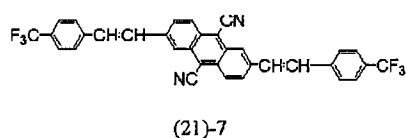
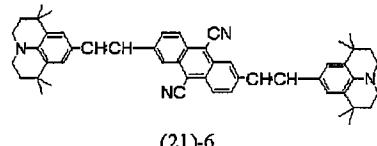
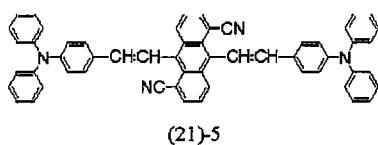
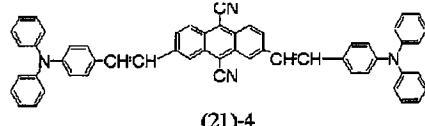
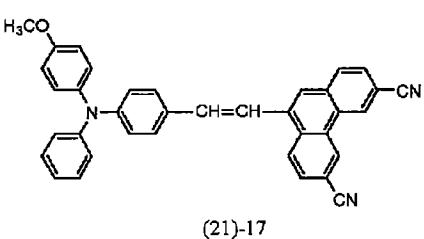
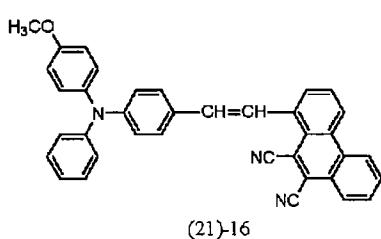
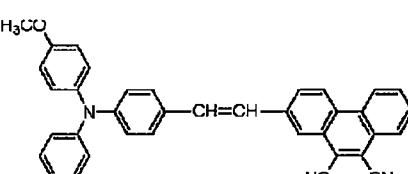
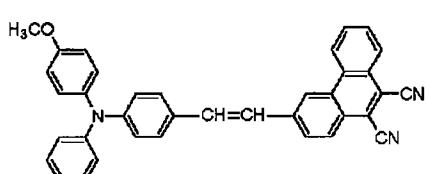
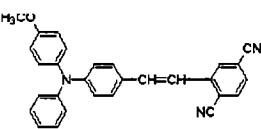
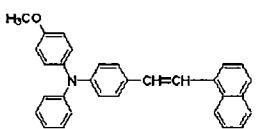
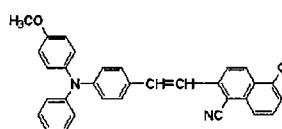
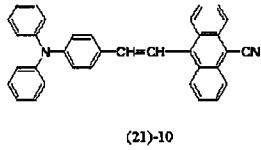
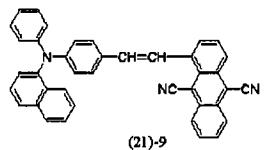
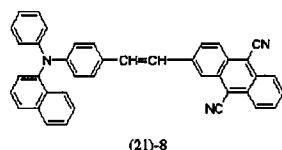
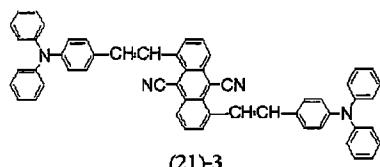
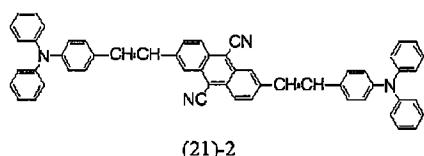
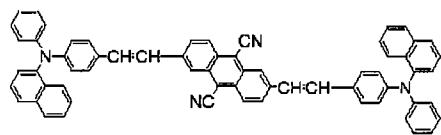
0で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつこの電子輸送性発光層の陰極側に接して前記ホールブロッキング層が存在する、請求項25に記載の有機電界発光素子。

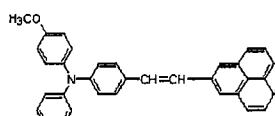
【請求項 29】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも前記発光層が、前記構造式（21）-1～（21）-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールプロッキング層が存在する、請求項25に記載の有機電界発光素子。

【請求項 30】 前記混合物における前記アミノスチリル化合物の割合が 1.0～1.00 重量% である、請求項 2

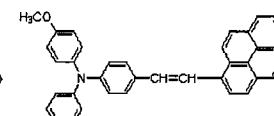
【請求項 3 1】 発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも 1 部が、下記構造式 (21)-1 ~ (21)-20 で示されるアミノスチリル化合物の少なくとも 1 種と、600nm～700nm の範囲に発光極大を有する赤色発光色素とを含んだ混合物からなり、かつこの混合物で構成された層の陰極側に接してホールプロッキング層が存在することを特徴とする、有機電界発光素子。

【化 1 0】

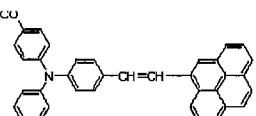




(21)-18



(21)-19



(21)-20

【請求項32】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記構造式(21)－1～(21)－20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層に接して陰極側に前記ホールブロッキング層が存在する、請求項31に記載の有機電界発光素子。

【請求項 3 3】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層に接して陰極側に前記ホールブロッキング層が存在する、請求項31に記載の有機電界発光素子。

【請求項34】 前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつこの電子輸送性発光層の陰極側に接して前記ホールブロッキング層が存在する、請求項31に記載の有機電界発光素子。

【請求項 3 5】 前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも前記発光層が、前記構造式（21）-1～（21）-20で示されるアミノスチリル化合物の少なくとも 1 種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在する、請求項 3 1 に記載の有機電界発光素子。

【請求項36】 前記混合物における前記アミノスチリル化合物の割合が10～100重量%である、請求項31に記載の有機電界発光素子。

【発明の詳細な説明】

[0001]

【発明の属する技術分野】本発明は、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子（有機EL素子）に関するものである。

[0002]

【従来の技術】軽量で高効率のフラットパネルディスプレイが、例えばコンピュータやテレビジョンの画面表示

【0003】まず、ブラウン管（CRT）は、輝度が高く、色再現性が良いため、現在ディスプレイとして最も多く使われているが、嵩高く、重く、また消費電力も高いという問題がある。

【0004】また、軽量で高効率のフラットパネルディスプレイとして、アクティブマトリックス駆動などの液晶ディスプレイが商品化されている。しかしながら、液晶ディスプレイは、視野角が狭く、また、自発光でないため周囲が暗い環境下ではバックライトの消費電力が大きいことや、今後実用化が期待されている高精細度の高速ビデオ信号に対して十分な応答性能を有しない等の問題点がある。特に、大画面サイズのディスプレイを製造することは困難であり、そのコストが高い等の課題もある。

【0005】これに対する代替として、発光ダイオードを用いたディスプレイの可能性があるが、やはり製造コストが高く、また、1つの基板上に発光ダイオードのマトリックス構造を形成することが難しい等の問題があり、ブラウン管に取って代わる低価格のディスプレイ候補としては、実用化までの課題が大きい。

【0006】これらの諸課題を解決する可能性のあるフラットパネルディスプレイとして、最近、有機発光材料を用いた有機電界発光素子（有機EL素子）が注目されている。即ち、発光材料として有機化合物を用いることにより、自発光で、応答速度が高速であり、視野角依存性の無いフラットパネルディスプレイの実現が期待されている。

【0007】有機電界発光素子の構成は、透光性の正極と金属陰極との間に、電流の注入によって発光する発光材料を含む有機薄膜を形成したものである。C. W. Tang、S.A. VanSlyke等は Applied Physics Letters第51巻12号913～915頁(1987年)掲載の研究報告において、有機薄膜を正孔輸送性材料からなる薄膜と電子輸送性材料からなる薄膜との2層構造として、各々の電極から有機膜中に注入されたホールと電子が再結合することにより発光する素子構造を開発した(シングルヘテロ構造の有機EL素子)。

【0008】この素子構造では、正孔輸送材料または電子輸送材料のいずれかが発光材料を兼ねており、発光は発光材料の基底状態と励起状態のエネルギーギャップに対応した波長帯で起きる。このような2層構造により、大幅な駆動電圧の低減、発光効率の改善が行われた。

【0009】その後、C. Adachi, S. Tokita, T. Tsu

sics第27巻2号L269～L271頁（1988年）掲載の研究報告に記載されているように、正孔輸送材料、発光材料、電子輸送材料の3層構造（ダブルヘテロ構造の有機EL素子）が開発され、更に、C. W. Tang、S. A. VanSlyke、C. H. Chen等のJournal of Applied Physics 第65巻9号3610～3616頁（1989年）掲載の研究報告に記載されているように、電子輸送材料中に発光材料を含ませた素子構造などが開発された。これらの研究により、低電圧で、高輝度の発光の可能性が検証され、近年、研究開発が非常に活発に行われている。

【0010】発光材料に用いる有機化合物は、その多様性から、理論的には分子構造を変化させることによって発光色を任意に変えることができるという利点があると言える。従って、分子設計を施すことにより、フルカラーディスプレイに必要な色純度の良いR（赤）、G（緑）、B（青）の3色を揃えることは、無機物を用いた薄膜EL素子と比べて容易であると言える。

【0011】

【発明が解決しようとする課題】しかしながら、実際には有機電界発光素子においても、解決しなければならない問題がある。安定した高輝度の赤色発光素子の開発は難しく、現在報告されている電子輸送材料として、トリス（8-キノリノール）アルミニウム（以下、Alq₃と略称。）にDCM〔4-ジシアノメチレン-6-(p-ジメチルアミノスチリル)-2-メチル-4H-ピラン〕をドープした赤色発光の例（Chem. Funct. Dyes, Proc. Int. Symp., 2nd P.536(1993)等においても、最高輝度、信頼性ともにディスプレイ材料としては満足の行くものではない。

【0012】また、T.Tsutsui,D.U.KimがInorganic and Organic electroluminescence会議（1996、Berlin）で報告したBSB-BCNは、1000cd/m²以上の高い輝度を実現しているが、フルカラーに対応する赤色としての色度が完全なものとは言えない。

【0013】さらに高輝度で安定かつ色純度の高い赤色発光素子の実現が、望まれているのが現状である。

【0014】また、特開平7-188649号（特願平6-148798号）においては、特定のジスチリル化合物を有機電界発光材料とすることを提案しているが、

目的の発光色が青色であり、赤色用ではない。一方、有機電界発光素子の積層構造の中にホールと電子のエネルギー的な閉じ込め構造を作ることによって発光層にてホールと電子が効率良く結合し、高い輝度および発光材料独自の純粋な発光を得られることが報告されている（特開平10-79297、特開平11-204258、特開平11-204264、特開平11-204259等）が、目的の発光色はやはり青色であり、赤色用ではない。

【0015】本発明の目的は、高輝度かつ安定な赤色又は赤色様発光を有する有機電界発光素子を提供することにある。

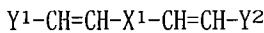
【0016】本発明の第二の目的は、本来高い蛍光収率を有し、また熱安定性にも優れた本発明の化合物を含んだ混合物を含有する有機電界発光素子において発光層でのホールと電子の再結合を促進し、さらに高輝度かつ高効率な発光を呈する有機電界発光素子を提供することにある。

【0017】

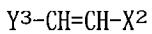
【課題を解決するための手段】本発明は上記課題を解決するために鋭意検討した結果、発光材料として特定のスチリル化合物と、効率良くエネルギーを伝達することが可能な材料等との混合物を用いることによって、安定した、高輝度のフルカラーディスプレイ実現に極めて有用な高信頼性の赤色発光素子を提供できることを見出し、本発明に到達したものである。

【0018】即ち、本発明は、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、下記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物からなることを特徴とする、有機電界発光素子に係わるものである。

一般式[I]：

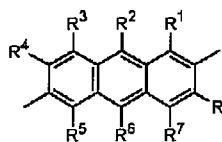


一般式[II]：

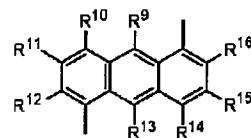


[但し、前記一般式[I]において、X¹は下記一般式(1)～(4)のいずれかで表される基であり、

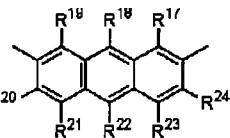
【化11】



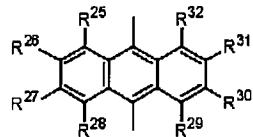
(1)



(2)



(3)

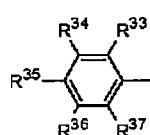


(4)

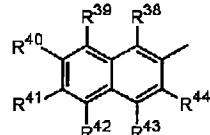
(但し、前記一般式(1)～(4)中のR¹～R⁸、R⁹～R¹⁶、R¹⁷～R²⁴、及びR²⁵～R³²のそれぞれにおいて、少なくとも一つがハロゲン原子(例えばフッ素、塩素など:以下、同様)、ニトロ基、シアノ基、トリフルオロメチル基から選ばれた基であり、その他は水素原子、アルキル基、アリール基、アルコキシ基、ハロゲン原子、ニト

ロ基、シアノ基及びトリフルオロメチル基から選ばれた基である。また、それらが同一であっても異なっても良い。)

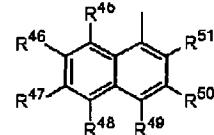
また、前記一般式[II]において、X²は下記一般式(5)～(17)のいずれかで表される基であり、
【化12】



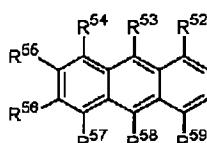
(5)



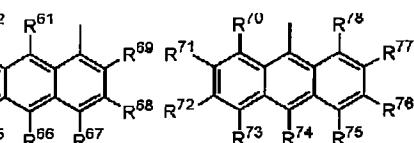
(6)



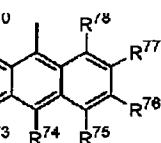
(7)



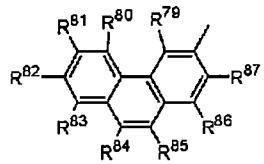
(8)



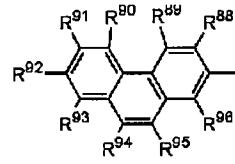
(9)



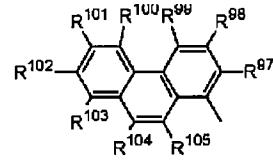
(10)



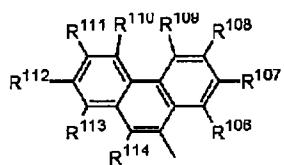
(11)



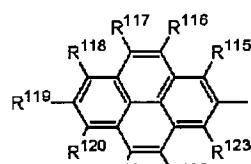
(12)



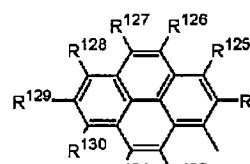
(13)



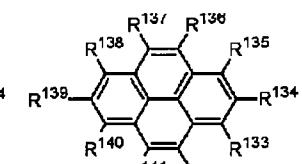
(14)



(15)



(16)



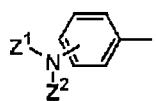
(17)

(但し、前記一般式(5)～(17)において、R³³～R⁴⁹は水素原子、又はハロゲン原子、ニトロ基、シアノ

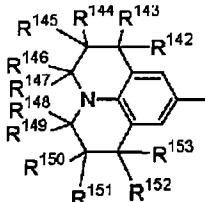
基、トリフルオロメチル基から選ばれた基である。また、それらが同一であっても異なっても良い。)

また、前記一般式[II]及び[III]中のY¹、Y²及びY³は水素

式(18)～(20)のいずれかで表される置換基を有しても良いアリール基から選ばれた基であり、それらが



(18)



(19)

(但し、前記一般式(18)中のZ¹及びZ²は水素原子、置換基を有しても良いアルキル基、又は置換基を有しても良いアリール基から選ばれた基であり、それらが同一であっても異なっても良い。また、前記一般式(19)及び(20)において、R¹⁴²～R¹⁵⁸は水素原子、置換基を有しても良いアルキル基、置換基を有しても良いアリール基、置換基を有しても良いアルコキシ基、ハロゲン原子、ニトロ基、シアノ基及びトリフルオロメチル基から選ばれた基であって、それらが同一であっても異なっても良い。)

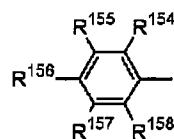
【0019】ここで、上記「混合物」とは、上記一般式[I]で表されるアミノスチリル化合物の少なくとも1種と、本発明の目的を達成するのに有利な性質を有するその他の化合物との混合物；又は上記一般式[II]で表されるアミノスチリル化合物の少なくとも1種と、本発明の目的を達成するのに有利な性質を有するその他の化合物との混合物；更には上記一般式[I]で表されるアミノスチリル化合物の少なくとも1種と、上記一般式[II]で表されるアミノスチリル化合物の少なくとも1種との混合物；或いは上記一般式[I]で表されるアミノスチリル化合物の少なくとも1種と、上記一般式[II]で表されるアミノスチリル化合物の少なくとも1種と、本発明の目的を達成するのに有利な性質を有するその他の化合物との混合物を意味する。

【0020】本発明は、上記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物を発光材料に用いるので、高輝度で安定な赤色発光が得られると共に、電気的、熱的或いは化学的にも安定性に優れた素子を提供できる。

【0021】本発明に用いる上記一般式[I]又は[II]で表されるアミノスチリル化合物を含む本発明に基づく混合物を形成するために使用可能な材料は、特に限定されるべきものではないが、例えば、本発明の上記一般式[I]又は[II]で表されるアミノスチリル化合物の他に、ホール輸送材料（例えば、芳香族アミン類等）、電子輸送材料（例えば、Alq₃、ピラゾリン類等）、又は一般に赤色発光用ドーパントとして用いられる一連の化合物（DCM及びその類似化合物、ポルフィリン類、フタロシアニン類、ペリレン化合物、ナイルレッド、スクアリウム化合物等）等が挙げられる。

同一であっても異なっても良い。

【化13】



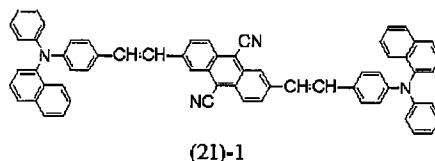
(20)

式[I]又は[II]で表されるアミノスチリル化合物を含む、本発明に基づく混合物の形成材料として用いることによって、正孔輸送性能、電荷輸送性能又は発光性能の向上を図ることが可能となり、より高輝度で安定な赤色発光が得られると共に、電気的、熱的或いは化学的にも一層優れた素子とすることができる。

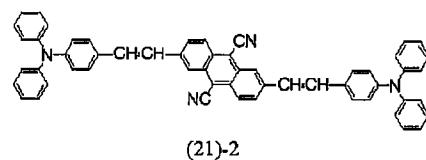
【0023】本発明に用いる上記一般式[I]又は[II]で表されるアミノスチリル化合物において、上記X¹（上記一般式(1)～(4)）及び上記X²（上記一般式(5)～(17)）は、本発明に用いる発光材料が赤色発光を生じる上で重要であるが、例えばベンゼン環の数が増えるに従って、有機発光材料の発光波長は長波長側にシフトする傾向がある。

【0024】本発明の有機電界発光素子において、発光材料である上記一般式[I]及び上記一般式[II]で示されるアミノスチリル化合物は、例えば下記構造式(21)-1～(21)-20のような分子構造の少なくとも一種が使用可能である。

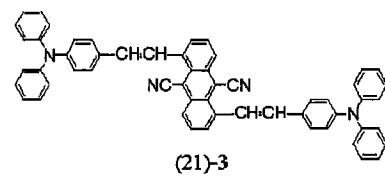
【化14】



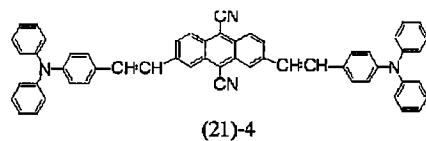
(21)-1



(21)-2



(21)-3



(21)-4

ており、前記有機層のうちの少なくとも電子輸送層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物、若しくは前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であってよい。

【0030】また、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物、若しくは前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であってよい。

【0031】また、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、上記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物、若しくは前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、上記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物、若しくは前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であってよい。

【0032】また、前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも発光層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物、若しくは前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であってよい。

【0033】さらに本発明は、前記混合物における前記アミノスチリル化合物の割合が、10～100重量%であることが好ましい。

【0034】また、本発明は、本来高い蛍光収率を有し、また熱安定性にも優れた上記の本発明の化合物を含んだ混合物を含有する有機電界発光素子において、発光層の陰極側にホール(正孔)ブロッキング層を置くことにより、発光層にてホールと電子の再結合が効率良く行われ、発光材料独自の純粋な発光が高輝度かつ高効率に得られる有機電界発光素子を提供するに至ったものである。

【0035】即ち、本発明はまた、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物、若しくは前記構造式(21)-1～(21)-20で示されるアミノスチリル化合物(以下、同様)の少なくとも1種を含んだ混合物(この混合物には、前記した600nm～700nmに発光極大を有する赤色発光色素が含まれてよい。：以下、同様)からなり、かつこの混合物で構

在することを特徴とする、有機電界発光素子に係わるものである。

【0036】例えば、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも電子輸送層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在することが可能である。

【0037】また、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくともホール輸送層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在することが可能である。

【0038】また、前記有機層が、ホール輸送層と電子輸送層とが積層された有機積層構造を有しており、前記ホール輸送層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記電子輸送層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつこの電子輸送性発光層の陰極側に接して前記ホールブロッキング層が存在することが可能である。

【0039】また、前記有機層が、ホール輸送層と発光層と電子輸送層とが積層された有機積層構造を有しており、前記有機層のうちの少なくとも前記発光層が、前記一般式〔I〕又は〔II〕で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物層であり、かつ前記混合物層の陰極側に接して前記ホールブロッキング層が存在することが可能である。

【0040】さらに、前記混合物における前記アミノスチリル化合物の割合が10～100重量%であることが好ましい。

【0041】また、ホールブロッキング層に適した材料とは、次のようなエネルギー状態を有するものであることが望ましい。すなわち、ホールブロッキング層を形成する材料の最高占有分子軌道レベルが、ホールブロッキング層の陽極側に接する層を形成する材料の最高占有分子軌道レベルより低いエネルギーレベルにあること、なおかつホールブロッキング層を形成する材料の最低非占有分子軌道レベルが、ホールブロッキング層の陽極側に接する層を形成する材料の最低非占有分子軌道レベルより高いエネルギーレベルにあり、またホールブロッキング層の陰極側に接する層を形成する材料の最低非占有分子軌道レベルより低いエネルギーレベルにあることである。

【0042】このような材料として、特開平10-79

4264、特開平11-204259等に示されたフェナントロリン誘導体が挙げられるが、上記のエネルギーレベルの条件を満たすものであれば、フェナントロリン誘導体に限定されるものではない。

【0043】図1～図4及び図5～図8は、本発明に基づく有機電界発光素子の例をそれぞれ示すものである。

【0044】図1は陰極3を発光光20が透過する透過型有機電界発光素子Aであって、発光光20は保護層4の側からも観測できる。図2は陰極3での反射光も発光光20として得る反射型有機電界発光素子Bを示す。

【0045】図中、1は有機電界発光素子を形成するための基板であり、ガラス、プラスチック及び他の適宜の材料を用いることができる。また、有機電界発光素子を他の表示素子と組み合わせて用いる場合には、基板を共用することもできる。2は透明電極(陽極)であり、ITO(Indium tin oxide)、SnO₂等を使用できる。

【0046】また、5は有機発光層であり、上記したアミノスチリル化合物を含んだ混合物を発光材料として含有している。この発光層について、有機電界発光20を得る層構成としては、従来公知の種々の構成を用いることができる。後述するように、例えば、正孔輸送層と電子輸送層のいずれかを構成する材料が発光性を有する場合、これらの薄膜を積層した構造を使用できる。更に本発明の目的を満たす範囲で電荷輸送性能を上げるために、正孔輸送層と電子輸送層のいずれか若しくは両方が、複数種の材料の薄膜を積層した構造、または、複数種の材料を混合した組成からなる薄膜を使用するのを妨げない。また、発光性能を上げるために、少なくとも1種以上の蛍光性の材料を用いて、この薄膜を正孔輸送層と電子輸送層の間に挟持した構造、更に少なくとも1種以上の蛍光性の材料を正孔輸送層若しくは電子輸送層、またはこれらの両方に含ませた構造を使用しても良い。これらの場合には、発光効率を改善するために、正孔または電子の輸送を制御するための薄膜をその層構成に含ませることも可能である。

【0047】例えば上記の構造式(21)で例示したアミノスチリル化合物は、電子輸送性能と正孔輸送性能の両方を持つため、素子構成中、電子輸送層を兼ねた、上記アミノスチリル化合物を含んだ混合物からなる発光層としても、或いは正孔輸送層を兼ねた、上記アミノスチリル化合物を含んだ混合物からなる発光層としても用いることが可能である。また、このアミノスチリル化合物を含んだ混合物を発光層として、電子輸送層と正孔輸送層とで挟み込んだ構成とすることも可能である。図5及び図6は、上記の構成に加えて、発光層5の陰極側に接してフェナントロリン誘導体からなるホールブロッキング層21を設けたものである。

【0048】なお、図1及び図2、図5及び図6中、3

の活性な金属とAg、Al、In等の金属との合金、或いはこれらを積層した構造を使用できる。透過型の有機電界発光素子においては、陰極の厚さを調節することにより、用途に合った光透過率を得ることができる。また、図中の4は封止・保護層であり、有機電界発光素子全体を覆う構造とすることにより、その効果が上がる。気密性が保たれれば、適宜の材料を使用することができる。また、8は電流注入用の駆動電源である。

【0049】本発明に基づく有機電界発光素子において、有機層が、正孔輸送層と電子輸送層とが積層された有機積層構造(シングルヘテロ構造)を有しており、正孔輸送層又は電子輸送層の形成材料として前記アミノスチリル化合物を含んだ混合物が用いられてよい。或いは、有機層が、正孔輸送層と発光層と電子輸送層とが順次積層された有機積層構造(ダブルヘテロ構造)を有しており、発光層の形成材料として前記スチリル化合物を含んだ混合物が用いられてよい。

【0050】このような有機積層構造を有する有機電界発光素子の例を示すと、図3は、透光性の基板1上に、透光性の陽極2と、正孔輸送層6と電子輸送層7とからなる有機層5aと、陰極3とが順次積層された積層構造を有し、この積層構造が保護膜4によって封止されてなる、シングルヘテロ構造の有機電界発光素子Cである。図7では、電子輸送層7及び/又は正孔輸送層6の陰極側に接してホールブロッキング層21が設けられている。

【0051】図3、図7に示すように発光層を省略した層構成の場合には、正孔輸送層6と電子輸送層7の界面から所定波長の発光20を発生する。これらの発光は基板1側から観測される。

【0052】また、図4は、透光性の基板1上に、透光性の陽極2と、正孔輸送層10と発光層11と電子輸送層12とからなる有機層5bと、陰極3とが順次積層された積層構造を有し、この積層構造が保護膜4によって封止されてなる、ダブルヘテロ構造の有機電界発光素子Dである。図8では、発光層11の陰極側に接してホールブロッキング層21が設けられている。

【0053】図4に示した有機電界発光素子においては、陽極2と陰極3の間に直流電圧を印加することにより、陽極2から注入された正孔が正孔輸送層10を経て、また陰極3から注入された電子が電子輸送層12を経て、それぞれ発光層11に到達する。この結果、発光層11においては電子/正孔の再結合が生じて一重項励起子が生成し、この一重項励起子から所定波長の発光を発生する。

【0054】上述した各有機電界発光素子C、Dにおいて、基板1は、例えば、ガラス、プラスチック等の光透過性の材料を適宜用いることができる。また、他の表示素子と組み合わせて用いる場合や、図3及び図4、図7

場合等は、この基板を共用としてよい。また、素子C、Dはいずれも、透過型、反射型のいずれの構造も採りうる。

【0055】また、陽極2は、透明電極であり、ITO(indium tin oxide)やSnO₂等が使用できる。この陽極2と正孔輸送層6(又は正孔輸送層10)との間に、電荷の注入効率を改善する目的で、有機物若しくは有機金属化合物からなる薄膜を設けてもよい。なお、保護膜4が金属等の導電性材料で形成されている場合は、陽極2の側面に絶縁膜が設けられていてもよい。

【0056】また、有機電界発光素子Cにおける有機層5aは、正孔輸送層6と電子輸送層7とが積層された有機層であり、これらのいずれか又は双方に上記したアミノスチリル化合物を含んだ混合物が含有され、発光性の正孔輸送層6又は電子輸送層7としてよい。有機電界発光素子Dにおける有機層5bは、正孔輸送層10と上記したアミノスチリル化合物を含んだ混合物を含有する発光層11と電子輸送層12とが積層された有機層であるが、その他、種々の積層構造を取ることができる。例えば、正孔輸送層と電子輸送層のいずれか若しくは両方が発光性を有していてもよい。

【0057】また、正孔輸送層において、正孔輸送性能を向上させるために、複数種の正孔輸送材料を積層した正孔輸送層を形成してもよい。

【0058】また、有機電界発光素子Cにおいて、発光層は電子輸送性発光層7であってよいが、電源8から印加される電圧によっては、正孔輸送層6やその界面で発光される場合がある。同様に、有機電界発光素子Dにおいて、発光層は層11以外に、電子輸送層12であってもよく、正孔輸送層10であってもよい。発光性能を向上させるために、少なくとも1種の蛍光性材料を用いた発光層11を正孔輸送層と電子輸送層との間に挟持させた構造であるのがよい。または、この蛍光性材料を正孔輸送層又は電子輸送層、或いはこれら両層に含有させた構造を構成してよい。このような場合、発光効率を改善するために、正孔又は電子の輸送を制御するための薄膜(ホールブロッキング層やエキシトン生成層など)をその層構成に含ませることも可能である。

【0059】また、陰極3に用いる材料としては、Li、Mg、Ca等の活性な金属とAg、Al、In等の金属との合金を使用でき、これらの金属層が積層した構造であってもよい。なお、陰極の厚みや材質を適宜選択することによって、用途に見合った有機電界発光素子を作製できる。

【0060】また、保護膜4は、封止膜として作用するものであり、有機電界発光素子全体を覆う構造とすることで、電荷注入効率や発光効率を向上できる。なお、その気密性が保たれれば、アルミニウム、金、クロム等の単金属又は合金など、適宜その材料を選択できる。

流は通常、直流であるが、パルス電流や交流を用いてもよい。電流値、電圧値は、素子破壊しない範囲内であれば特に制限はないが、有機電界発光素子の消費電力や寿命を考慮すると、なるべく小さい電気エネルギーで効率良く発光させることが望ましい。

【0062】次に、図9は、本発明の有機電界発光素子を用いた平面ディスプレイの構成例である。図示の如く、例えばフルカラーディスプレイの場合は、赤(R)、緑(G)及び青(B)の3原色を発光可能な有機層5(5a、5b)が、陰極3と陽極2との間に配されている。陰極3及び陽極2は、互いに交差するストライプ状に設けることができ、輝度信号回路14及びシフトレジスタ内蔵の制御回路15により選択されて、それぞれに信号電圧が印加され、これによって、選択された陰極3及び陽極2が交差する位置(画素)の有機層が発光するように構成される。

【0063】即ち、図9は例えば8×3RGB単純マトリックスであって、正孔輸送層と、発光層および電子輸送層のいずれか少なくとも一方とからなる積層体5を陰極3と陽極2の間に配置したものである(図3及び図7、又は図4及び図8参照)。陰極と陽極は、ともにストライプ状にパターニングするとともに、互いにマトリクス状に直交させ、シフトレジスタ内蔵の制御回路15および14により時系列的に信号電圧を印加し、その交叉位置で発光するように構成されたものである。かかる構成のEL素子は、文字・記号等のディスプレイとしては勿論、画像再生装置としても使用できる。また陰極3と陽極2のストライプ状パターンを赤(R)、緑(G)、青(B)の各色毎に配し、マルチカラーあるいはフルカラーの全固体型フラットパネルディスプレイを構成することが可能となる。

【0064】

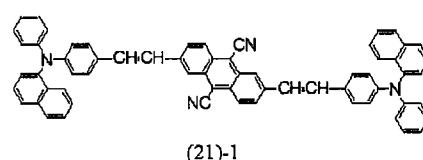
【実施例】次に本発明を実施例について具体的に説明するが、本発明は以下の実施例に限定されるものではない。

【0065】実施例1

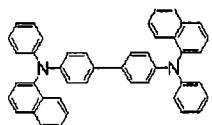
本実施例は、一般式[I]のアミノスチリル化合物のうち、下記構造式(21)-1のアミノスチリル化合物と下記構造式のα-NPD(α-ナフチルフェニルジアミン)との混合物を正孔輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。

【0066】

【化15】構造式(21)-1:



α-NPD:

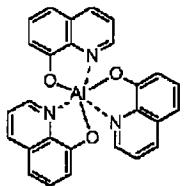


【0067】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm × 30 mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0 mm × 2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10⁻⁴ Pa以下の真空下で上記構造式(21)-1と正孔輸送材料であるα-NPDを重量比1:1で、例えば50 nmの厚さに正孔輸送層(兼発光層)として成膜した。蒸着レートは各々0.1 nm/秒とした。

【0068】さらに、電子輸送層材料として下記構造式のAlq₃(トリス(8-キノリノール)アルミニウム)を正孔輸送層に接して蒸着した。Alq₃からなるこの電子輸送層の膜厚も例えば50 nmとし、蒸着レートは0.2 nm/秒とした。

【0069】

【化16】Alq₃:



【0070】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm(Mg膜)及び150 nm(Ag膜)の厚さに形成し、実施例1による図3に示したが如き有機電界発光素子を作製した。

【0071】このように作製した実施例1の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、680 nm付近に発光ピークを有するスペクトルを得た。分光測定は、大塚電子社製のフォトダイオードアレイを検出器とした分光器を用いた。また、電圧-輝度測定を行ったところ、8 Vで500 cd/m²の輝度が得られた。

【0072】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで250時間であった。

【0073】実施例2

本実施例は、一般式[I]のアミノスチリル化合物のうち、上記構造式(21)-1のアミノスチリル化合物とAlq₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例であ

【0074】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm × 30 mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0 mm × 2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10⁻⁴ Pa以下の真空下で、上記構造式のα-NPDを例えれば50 nmの厚さに正孔輸送層として成膜した。蒸着レートは0.1 nm/秒とした。

【0075】さらに、上記構造式(21)-1のアミノスチリル化合物と電子輸送性材料であるAlq₃を重量比1:1で正孔輸送層に接して蒸着した。上記構造式(21)-1のアミノスチリル化合物とAlq₃との混合物からなる電子輸送層(兼発光層)の膜厚も例えれば50 nmとし、蒸着レートは各々0.2 nm/秒とした。

【0076】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm(Mg膜)及び150 nm(Ag膜)の厚さに形成し、実施例2による図3に示した如き有機電界発光素子を作製した。

【0077】このように作製した実施例2の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、690 nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8 Vで600 cd/m²の輝度が得られた。

【0078】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで200時間であった。

【0079】実施例3

本実施例は、一般式[I]のアミノスチリル化合物のうち、上記構造式(21)-1のアミノスチリル化合物とAlq₃との混合物を電子輸送性発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。

【0080】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm × 30 mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0 mm × 2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10⁻⁴ Pa以下の真空下で、上記構造式のα-NPDを例えれば30 nmの厚さに正孔輸送層として成膜した。蒸着レートは0.2 nm/秒とした。

【0081】さらに、発光材料として上記構造式(21)-1のアミノスチリル化合物と電子輸送性材料であるAlq₃を重量比1:1で正孔輸送層に接して蒸着した。上記構造式(21)-1のアミノスチリル化合物と

n mとし、蒸着レートは各々0. 2 nm／秒とした。

【0082】さらに、電子輸送性材料として上記構造式のA₁q₃を発光層に接して蒸着した。A₁q₃の膜厚を例えば30 nmとし、蒸着レートは0. 2 nm／秒とした。

【0083】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm／秒として例えば50 nm(Mg膜)及び150 nm(Ag膜)の厚さに形成し、実施例3による図4に示したが如き有機電界発光素子を作製した。

【0084】このように作製した実施例3の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、690 nmに発光ピークを有するスペクトルを得た。また、電圧－輝度測定を行ったところ、8 Vで800 cd/m²の輝度が得られた。

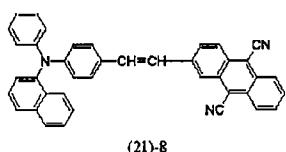
【0085】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また初期輝度100 cd/m²で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで500時間であった。

【0086】実施例4

本実施例は、一般式[I]又は[II]のアミノスチリル化合物のうち、下記構造式(21)-8のアミノスチリル化合物と上記構造式(21)-1のアミノスチリル化合物との混合物を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。

【0087】

【化17】構造式(21)-8：



【0088】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm×30 mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0 mm×2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10⁻⁴ Pa以下の真空中で上記構造式のα-NPDを例えば30 nmの厚さに正孔輸送層として成膜した。蒸着レートは0. 2 nm／秒とした。

【0089】さらに、発光材料として上記構造式(21)-8のアミノスチリル化合物と上記構造式(21)-1のアミノスチリル化合物を重量比1:3で正孔輸送層に接して蒸着した。上記構造式(21)-8のアミノスチリル化合物と上記構造式(21)-1のアミノスチリル化合物との混合物からなる発光層の膜厚も例えば30 nmとし、蒸着レートは上記構造式(21)-8の化

物は0. 3 nm／秒とした。

【0090】さらに、電子輸送性材料として上記構造式のA₁q₃を発光層に接して蒸着した。A₁q₃の膜厚を例えば30 nmとし、蒸着レートは0. 2 nm／秒とした。

【0091】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm／秒として例えば50 nm(Mg膜)及び150 nm(Ag膜)の厚さに形成し、実施例4による図4に示したが如き有機電界発光素子を作製した。

【0092】このように作製した実施例4の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、710 nmに発光ピークを有するスペクトルを得た。また、電圧－輝度測定を行ったところ、8 Vで300 cd/m²の輝度が得られた。

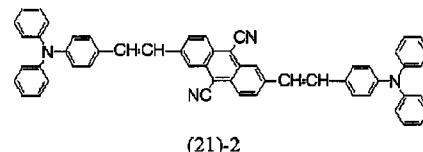
【0093】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また初期輝度50 cd/m²で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで200時間であった。

【0094】実施例5

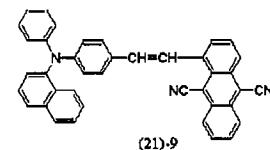
本実施例は、一般式[I]又は[II]のアミノスチリル化合物のうち、下記構造式(21)-9のアミノスチリル化合物と下記構造式(21)-2のアミノスチリル化合物との混合物(重量比1:3)を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例4に準拠して有機電界発光素子を作製した。

【0095】

【化18】構造式(21)-2：



構造式(21)-9：



【0096】このように作製した実施例5の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、750 nmに発光ピークを有するスペクトルを得た。また、電圧－輝度測定を行ったところ、8 Vで20 cd/m²の輝度が得られた。

【0097】この有機電界発光素子を作製後、窒素雰

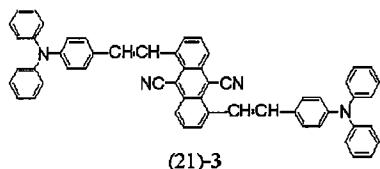
た。また初期輝度 20 cd/m^2 で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで 100 時間であった。

【0098】実施例 6

本実施例は、一般式 [I] 又は [II] のアミノスチリル化合物のうち、下記構造式 (21)-10 のアミノスチリル化合物と下記構造式 (21)-3 のアミノスチリル化合物との混合物（重量比 1 : 3）を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 4 に準拠して有機電界発光素子を作製した。

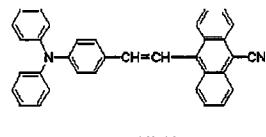
【0099】

【化19】構造式 (21)-3 :



(21)-3

構造式 (21)-10 :



(21)-10

【0100】このように作製した実施例 6 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて、発光特性を評価した。発光色は橙色であり、分光測定を行った結果、 620 nm に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、 8 V で 500 cd/m^2 の輝度が得られた。

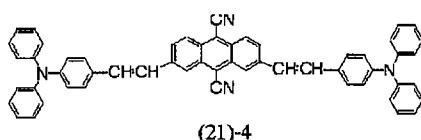
【0101】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかった。また初期輝度 100 cd/m^2 で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで 250 時間であった。

【0102】実施例 7

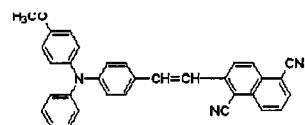
本実施例は、一般式 [I] 又は [II] のアミノスチリル化合物のうち、下記構造式 (21)-11 のアミノスチリル化合物と下記構造式 (21)-4 のアミノスチリル化合物との混合物（重量比 1 : 3）を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 4 に準拠して有機電界発光素子を作製した。

【0103】

【化20】構造式 (21)-4 :



(21)-4



(21)-11

【0104】このように作製した実施例 7 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて、発光特性を評価した。発光色は赤色であり、分光測定を行った結果、 660 nm に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、 8 V で 250 cd/m^2 の輝度が得られた。

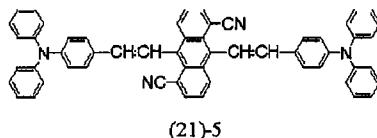
【0105】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかった。また初期輝度 100 cd/m^2 で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで 100 時間であった。

【0106】実施例 8

本実施例は、一般式 [I] 又は [II] のアミノスチリル化合物のうち、下記構造式 (21)-13 のアミノスチリル化合物と下記構造式 (21)-5 のアミノスチリル化合物との混合物（重量比 1 : 3）を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 4 に準拠して有機電界発光素子を作製した。

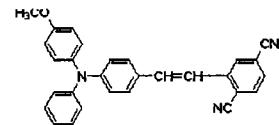
【0107】

【化21】構造式 (21)-5 :



(21)-5

構造式 (21)-13 :



(21)-13

【0108】このように作製した実施例 8 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて、発光特性を評価した。発光色は橙色であり、分光測定を行った結果、 615 nm に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、 8 V で 320 cd/m^2 の輝度が得られた。

【0109】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかった。また初期輝度 50 cd/m^2 で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで 150 時間であった。

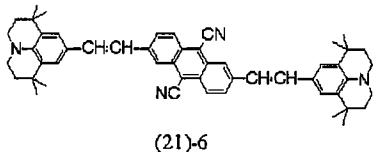
【0110】実施例 9

本実施例は、一般式 [I] 又は [II] のアミノスチリル化合

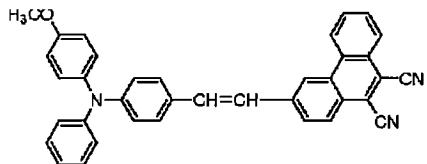
化合物と下記構造式(21)-6のアミノスチリル化合物との混合物(重量比1:3)を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例4に準拠して有機電界発光素子を作製した。

[0 1 1 1]

【化22】構造式(21)-6:



構造式 (21)-14:



(21)-14

【0112】このように作製した実施例9の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて、発光特性を評価した。発光色は赤色であり、分光測定を行った結果、670 nmに発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 Vで230 c.d./m²の輝度が得られた。

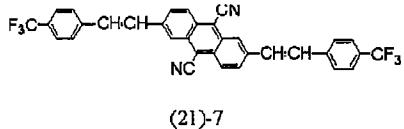
【0113】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また初期輝度100cd/m²で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで170時間であった。

【0114】実施例10

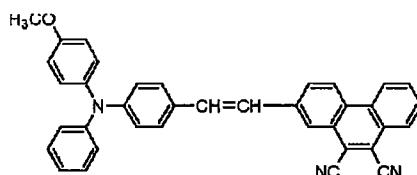
本実施例は、一般式[I]又は[II]のアミノスチリル化合物のうち、下記構造式(21)-15のアミノスチリル化合物と下記構造式(21)-7のアミノスチリル化合物との混合物(重量比1:3)を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例4に準拠して有機電界発光素子を作製した。

[0 1 1 5]

【化23】構造式(21)-7:



構造式(21)-15:



(21)-15

【0116】このように作製した実施例10の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて、発光特性を評価した。発光色は赤色であり、分光測定を行った結果、630 nmに発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 Vで700 cd/m²の輝度が得られた。

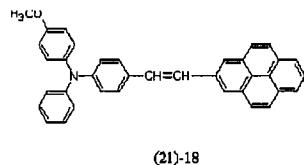
【0117】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また初期輝度50cd/m²で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで300時間であった。

【0118】実施例11

本実施例は、一般式[I]又は[II]のアミノスチリル化合物のうち、下記構造式(21)－18のアミノスチリル化合物と上記構造式(21)－1のアミノスチリル化合物との混合物(重量比3:1)を発光層として用い、ダブルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例4に準拠して有機電界発光素子を作製した。

[0 1 1 9]

【化24】構造式(21)-18:



【0120】このように作製した実施例11の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて、発光特性を評価した。発光色は赤色であり、分光測定を行った結果、640 nmに発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 Vで 450 cd/m² の輝度が得られた。

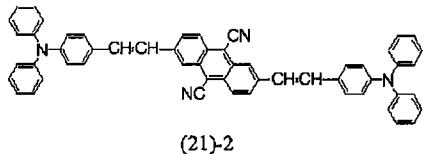
【0121】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また初期輝度50cd/m²で電流値を一定に通電して連続発光して強制劣化させた際、輝度が半減するまで170時間であった。

【0122】実施例12

本実施例は、一般式 [I] のアミノスチリル化合物のうち、下記構造式(21)-2のアミノスチリル化合物と A1q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界

【0123】

【化25】構造式(21)-2:



【0124】このように作製した実施例12の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、720 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで300 cd/m²の輝度が得られた。

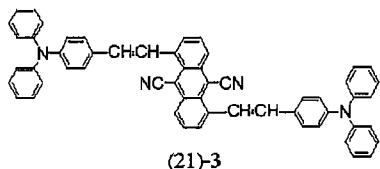
【0125】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度50 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで220時間であった。

【0126】実施例13

本実施例は、一般式[I]のアミノスチリル化合物のうち、下記構造式(21)-3のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0127】

【化26】構造式(21)-3:



【0128】このように作製した実施例13の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、660 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで500 cd/m²の輝度が得られた。

【0129】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで300時間であった。

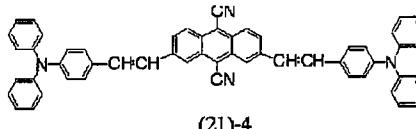
【0130】実施例14

本実施例は、一般式[I]のアミノスチリル化合物のうち、下記構造式(21)-4のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シ

る。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0131】

【化27】構造式(21)-4:



【0132】このように作製した実施例14の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、650 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで850 cd/m²の輝度が得られた。

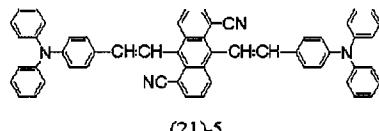
【0133】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで200時間であった。

【0134】実施例15

本実施例は、一般式[I]のアミノスチリル化合物のうち、下記構造式(21)-5のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0135】

【化28】構造式(21)-5:



【0136】このように作製した実施例15の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、630 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで750 cd/m²の輝度が得られた。

【0137】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで300時間であった。

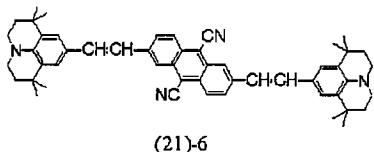
【0138】実施例16

本実施例は、一般式[I]のアミノスチリル化合物のうち、下記構造式(21)-6のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シ

る。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0139】

【化29】構造式(21)-6:



【0140】このように作製した実施例16の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、700 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで250 cd/m²の輝度が得られた。

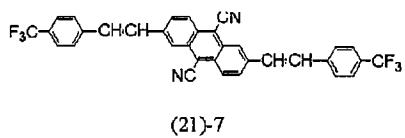
【0141】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度50 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで200時間であった。

【0142】実施例17

本実施例は、一般式[I]のアミノスチリル化合物のうち、下記構造式(21)-7のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0143】

【化30】構造式(21)-7:



このように作製した実施例17の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、665 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで800 cd/m²の輝度が得られた。

【0144】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで450時間であった。

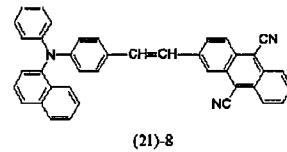
【0145】実施例18

本実施例は、一般式[II]のアミノスチリル化合物のうち、下記構造式(21)-8のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シ

る。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0146】

【化31】構造式(21)-8:



【0147】このように作製した実施例18の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、690 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで700 cd/m²の輝度が得られた。

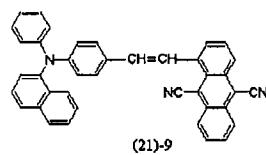
【0148】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで500時間であった。

【0149】実施例19

本実施例は、一般式[II]のアミノスチリル化合物のうち、下記構造式(21)-9のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0150】

【化32】構造式(21)-9:



【0151】このように作製した実施例19の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、660 nm付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8Vで500 cd/m²の輝度が得られた。

【0152】この有機電界発光素子を作製後、窒素雰囲気下に1ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで450時間であった。

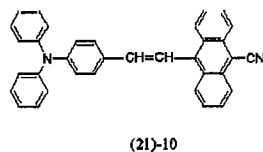
【0153】実施例20

本実施例は、一般式[II]のアミノスチリル化合物のう

と A₁q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 2 に準拠して有機電界発光素子を作製した。

【0154】

【化33】構造式 (21)-10 :



(21)-10

【0155】このように作製した実施例 20 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例 1 と同様に分光測定を行った結果、610 nm 付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 V で 750 cd/m² の輝度が得られた。

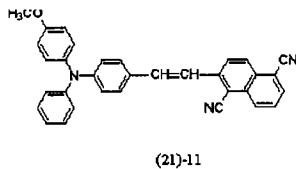
【0156】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度 100 cd/m² で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで 500 時間であった。

【0157】実施例 21

本実施例は、一般式 [II] のアミノスチリル化合物のうち、下記構造式 (21)-11 のアミノスチリル化合物と A₁q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 2 に準拠して有機電界発光素子を作製した。

【0158】

【化34】構造式 (21)-11 :



(21)-11

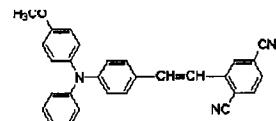
【0159】このように作製した実施例 21 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例 1 と同様に分光測定を行った結果、620 nm 付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 V で 1200 cd/m² の輝度が得られた。

【0160】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度 100 cd/m² で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで 660 時間であった。

本実施例は、一般式 [II] のアミノスチリル化合物のうち、下記構造式 (21)-13 のアミノスチリル化合物と A₁q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 2 に準拠して有機電界発光素子を作製した。

【0162】

【化35】構造式 (21)-13 :



(21)-13

【0163】このように作製した実施例 22 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例 1 と同様に分光測定を行った結果、590 nm 付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 V で 1500 cd/m² の輝度が得られた。

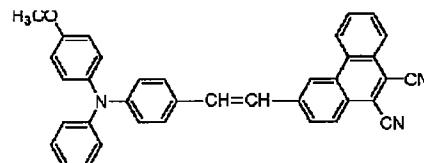
【0164】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかった。また、初期輝度 100 cd/m² で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで 500 時間であった。

【0165】実施例 23

本実施例は、一般式 [II] のアミノスチリル化合物のうち、下記構造式 (21)-14 のアミノスチリル化合物と A₁q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例 2 に準拠して有機電界発光素子を作製した。

【0166】

【化36】構造式 (21)-14 :



(21)-14

【0167】このように作製した実施例 23 の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例 1 と同様に分光測定を行った結果、630 nm 付近に発光ピークを有するスペクトルを得た。また、電圧一輝度測定を行ったところ、8 V で 1100 cd/m² の輝度が得られた。

【0168】この有機電界発光素子を作製後、窒素雰囲気下に 1 ヶ月間放置したが、素子劣化は観察されなかつ

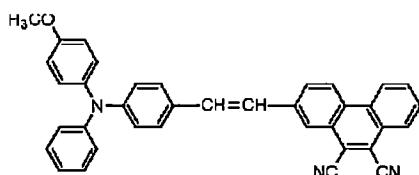
通電して連続発光し、強制劣化させた際、輝度が半減するまで500時間であった。

【0169】実施例24

本実施例は、一般式 [II] のアミノスチリル化合物のうち、下記構造式(21)-15のアミノスチリル化合物とA1q₃との混合物を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0170】

【化37】構造式(21)-15：



(21)-15

【0171】このように作製した実施例24の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例1と同様に分光測定を行った結果、630 nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで700 cd/m²の輝度が得られた。

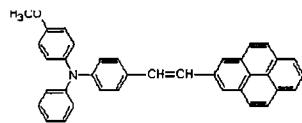
【0172】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで600時間であった。

【0173】実施例25

本実施例は、一般式 [II] のアミノスチリル化合物のうち、下記構造式(21)-18のアミノスチリル化合物とA1q₃との混合層を電子輸送性発光層として用い、シングルヘテロ構造の有機電界発光素子を作製した例である。層構造、成膜法とも、実施例2に準拠して有機電界発光素子を作製した。

【0174】

【化38】構造式(21)-18：



(21)-18

【0175】このように作製した実施例25の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例1と同様に分光測定を行った結果、580 nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで900 cd/m²の輝度が得

【0176】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100 cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで450時間であった。

【0177】実施例26

本実施例は、一般式 [I] のアミノスチリル化合物のうち、上記構造式(21)-1のアミノスチリル化合物と上記構造式のα-NPD (α-ナフチルフェニルジアミン)の混合物を正孔輸送性発光層として用い、図7に示した如き有機電界発光素子を作製した例である。

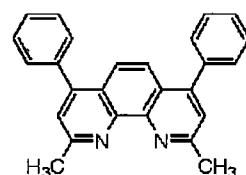
【0178】まず、真空蒸着装置中に、100 nmの厚さのITOからなる陽極が一表面に形成された30 mm × 30 mmのガラス基板をセッティングした。蒸着マスクとして複数の2.0 mm × 2.0 mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により10⁻⁴ Pa以下の真空中で上記構造式(21)-1のアミノスチリル化合物と正孔輸送材料であるα-NPDを重量比1:1で、例えば50 nmの厚さに正孔輸送層（兼発光層）として成膜した。蒸着レートは各々0.1 nm/秒とした。

【0179】さらに、ホールブロッキング層材料として下記構造式のバソクプロインを正孔輸送層に接して蒸着した。バソクプロインからなるこのホールブロッキング層の膜厚は例えば15 nmとし、蒸着レートは0.1 nm/秒とした。

【0180】さらに、電子輸送層材料として上記構造式のA1q₃ (トリス(8-キノリノール)アルミニウム)をホールブロッキング層に接して蒸着した。A1q₃からなるこの電子輸送層の膜厚も例えば50 nmとし、蒸着レートは0.2 nm/秒とした。

【0181】

【化39】バソクプロイン：



【0182】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1 nm/秒として例えば50 nm (Mg膜)および150 nm (Ag膜)の厚さに形成し、実施例26による図7に示した如き有機電界発光素子を作製した。

【0183】このように作製した実施例26の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、分光測定を行った結果、720 nm付近に発光ピークを有するスペクトルを得た。分光測定は、大塚電子社製のフォトダイオードアレイを検出器とした分光器を用いた。また、

2の輝度が得られた。

【0184】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度 50 c d/m^2 で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで200時間であった。

【0185】実施例27

本実施例は、一般式[I]のアミノスチリル化合物のうち、上記構造式(21)-1のアミノスチリル化合物とAlq₃との混合物を電子輸送性発光層として用い、図8に示した如き有機電界発光素子を作製した例である。

【0186】まず、真空蒸着装置中に、100nmの厚さのITOからなる陽極が一表面に形成された30mm×30mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0mm×2.0mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により 10^{-4} Pa 以下の真空中で、上記構造式の $\alpha-NPD$ を例えば30nmの厚さに正孔輸送層として成膜した。蒸着レートは0.2nm/秒とした。

【0187】さらに、発光材料として上記構造式(21)-1のアミノスチリル化合物と電子輸送性材料であるAlq₃を重量比1:1で正孔輸送層に接して蒸着した。上記構造式(21)-1のアミノスチリル化合物とAlq₃との混合物からなる発光層の膜厚も例えば30nmとし、蒸着レートは各々0.2nm/秒とした。

【0188】さらに、ホールブロッキング層として上記構造式のバソクプロインを発光層に接して蒸着した。バソクプロインからなるこのホールブロッキング層の膜厚は例えば15nmとし、蒸着レートは0.1nm/秒とした。

【0189】さらに、電子輸送層材料として上記構造式のAlq₃をホールブロッキング層に接して蒸着した。Alq₃からなるこの電子輸送層の膜厚も例えば30nmとし、蒸着レートは0.2nm/秒とした。

【0190】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1nm/秒として例えば50nm(Mg膜)及び150nm(Ag膜)の厚さに形成し、実施例27による図8に示したが如き有機電界発光素子を作製した。

【0191】このように作製した実施例27の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例26と同様に分光測定を行った結果、720nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで 220 c d/m^2 の輝度が得られた。

【0192】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度 50 c d/m^2 で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減する

まで350時間であった。

【0193】実施例28

本実施例は、一般式[I]又は[II]のアミノスチリル化合物のうち、上記構造式(21)-8のアミノスチリル化合物と上記構造式(21)-1のアミノスチリル化合物との混合物を発光層として用い、図8に示した如き有機電界発光素子を作製した例である。

【0194】まず、真空蒸着装置中に、100nmの厚さのITOからなる陽極が一表面に形成された30mm×30mmのガラス基板をセッティングした。蒸着マスクとして、複数の2.0mm×2.0mmの単位開口を有する金属マスクを基板に近接して配置し、真空蒸着法により 10^{-4} Pa 以下の真空中で上記構造式の $\alpha-NPD$ を例えば30nmの厚さに正孔輸送層として成膜した。蒸着レートは0.2nm/秒とした。

【0195】さらに、発光材料として上記構造式(21)-8のアミノスチリル化合物と上記構造式(21)-1のアミノスチリル化合物を重量比1:3で正孔輸送層に接して蒸着した。上記構造式(21)-8のアミノスチリル化合物と上記構造式(21)-1のアミノスチリル化合物との混合物からなる発光層の膜厚も例えば30nmとし、蒸着レートは上記構造式(21)-8の化合物は0.1nm/秒、上記構造式(21)-1の化合物は0.3nm/秒とした。

【0196】さらに、ホールブロッキング層として上記構造式のバソクプロインを発光層に接して蒸着した。バソクプロインからなるこのホールブロッキング層の膜厚は例えば15nmとし、蒸着レートは0.1nm/秒とした。

【0197】さらに、電子輸送層材料として上記構造式のAlq₃を発光層に接して蒸着した。Alq₃の膜厚を例えば30nmとし、蒸着レートは0.2nm/秒とした。

【0198】陰極材料としてはMgとAgの積層膜を採用し、これも蒸着により、蒸着レート1nm/秒として例えば50nm(Mg膜)及び150nm(Ag膜)の厚さに形成し、実施例28による図8に示したが如き有機電界発光素子を作製した。

【0199】このように作製した実施例28の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例26と同様に分光測定を行った結果、710nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで 250 c d/m^2 の輝度が得られた。

【0200】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかつた。また、初期輝度 50 c d/m^2 で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減する

【0201】実施例29

本実施例は、一般式[I]又は[II]の上記アミノスチリル化合物のうち、上記構造式(21)-9のアミノスチリル化合物と上記構造式(21)-2のアミノスチリル化合物との混合物(重量比1:3)を電子輸送性発光層として用いた有機電界発光素子を作製した例である。層構造、成膜法とも実施例28に準拠して有機電界発光素子を作製した。

【0202】このように作製した実施例29の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例26と同様に分光測定を行った結果、750nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで15cd/m²の輝度が得られた。

【0203】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度20cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで150時間であった。

【0204】実施例30

本実施例は、一般式[I]又は[II]の上記アミノスチリル化合物のうち、上記構造式(21)-10のアミノスチリル化合物と上記構造式(21)-3のアミノスチリル化合物との混合物(重量比1:3)を電子輸送性発光層として用いた有機電界発光素子を作製した例である。層構造、成膜法とも実施例28に準拠して有機電界発光素子を作製した。

【0205】このように作製した実施例30の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例26と同様に分光測定を行った結果、620nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで450cd/m²の輝度が得られた。

【0206】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで350時間であった。

【0207】実施例31

本実施例は、一般式[I]又は[II]の上記アミノスチリル化合物のうち、上記構造式(21)-11のアミノスチリル化合物と上記構造式(21)-4のアミノスチリル化合物との混合物(重量比1:3)を電子輸送性発光層として用いた有機電界発光素子を作製した例である。層構造、成膜法とも実施例28に準拠して有機電界発光素子を作製した。

【0208】このように作製した実施例31の有機電界

て発光特性を評価した。発光色は赤色であり、実施例26と同様に分光測定を行った結果、660nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで200cd/m²の輝度が得られた。

【0209】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで150時間であった。

【0210】実施例32

本実施例は、一般式[I]又は[II]の上記アミノスチリル化合物のうち、上記構造式(21)-13のアミノスチリル化合物と上記構造式(21)-5のアミノスチリル化合物との混合物(重量比1:3)を電子輸送性発光層として用いた有機電界発光素子を作製した例である。層構造、成膜法とも実施例28に準拠して有機電界発光素子を作製した。

【0211】このように作製した実施例32の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は橙色であり、実施例26と同様に分光測定を行った結果、615nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで280cd/m²の輝度が得られた。

【0212】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減するまで250時間であった。

【0213】実施例33

本実施例は、一般式[I]又は[II]の上記アミノスチリル化合物のうち、上記構造式(21)-14のアミノスチリル化合物と上記構造式(21)-6のアミノスチリル化合物との混合物(重量比1:3)を電子輸送性発光層として用いた有機電界発光素子を作製した例である。層構造、成膜法とも実施例28に準拠して有機電界発光素子を作製した。

【0214】このように作製した実施例33の有機電界発光素子に、窒素雰囲気下で順バイアス直流電圧を加えて発光特性を評価した。発光色は赤色であり、実施例26と同様に分光測定を行った結果、670nm付近に発光ピークを有するスペクトルを得た。また、電圧-輝度測定を行ったところ、8Vで210cd/m²の輝度が得られた。

【0215】この有機電界発光素子を作製後、窒素雰囲気下に1カ月間放置したが、素子劣化は観察されなかった。また、初期輝度100cd/m²で電流値を一定に通電して連続発光し、強制劣化させた際、輝度が半減す

【0216】

【発明の作用効果】本発明の有機電界発光素子によれば、発光領域を有する有機層が陽極と陰極との間に設けられている有機電界発光素子において、前記有機層の少なくとも1部が、前記一般式[I]又は[II]で表されるアミノスチリル化合物の少なくとも1種を含んだ混合物からなるので、高輝度で安定な赤色又は赤色様発光を有する有機電界発光素子を提供することが可能となる。

【図面の簡単な説明】

【図1】本発明に基づく有機電界発光素子の一例の要部概略断面図である。

【図2】同、有機電界発光素子の他の例の要部概略断面図である。

【図3】同、有機電界発光素子の他の例の要部概略断面図である。

【図4】同、有機電界発光素子の他の例の要部概略断面図である。

【図5】同、有機電界発光素子の他の例の要部概略断面図である。

【図6】同、有機電界発光素子の他の例の要部概略断面図である。

【図7】同、有機電界発光素子の他の例の要部概略断面図である。

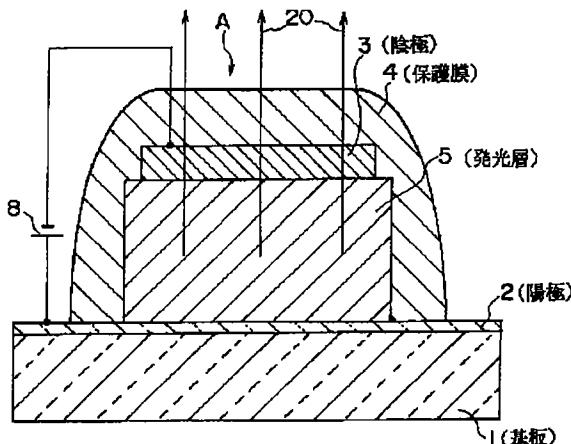
【図8】同、有機電界発光素子の更に他の例の要部概略断面図である。

【図9】同、有機電界発光素子を用いたフルカラーの平面ディスプレイの構成図である。

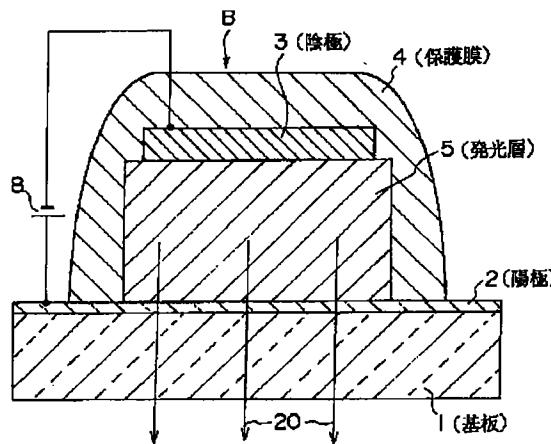
【符号の説明】

1…基板、2…透明電極（陽極）、3…陰極、4…保護膜、5、5a、5b…有機層、6…正孔輸送層、7…電子輸送層、8…電源、10…正孔輸送層、11…発光層、12…電子輸送層、14…輝度信号回路、15…制御回路、20…発光光、21…ホール（正孔）ブロッキング層、A、B、C、D…有機電界発光素子

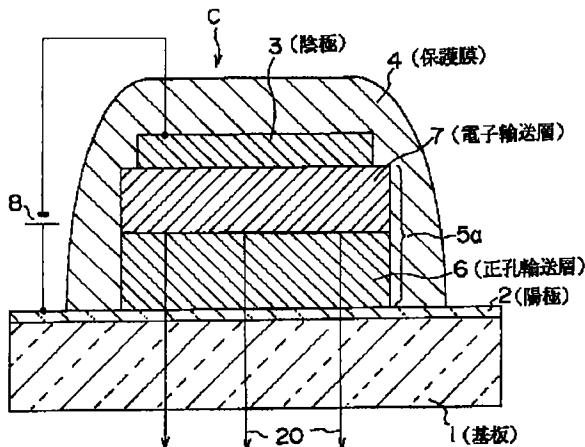
【図1】



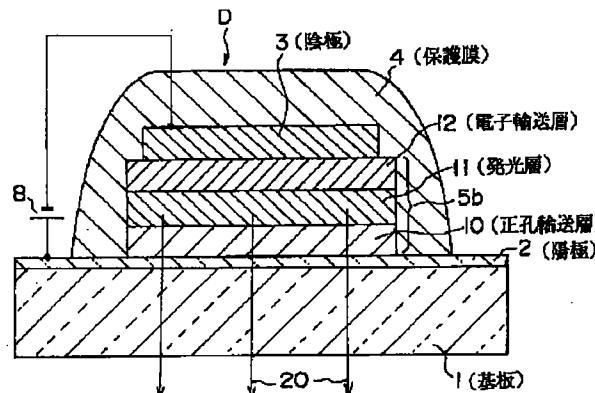
【図2】



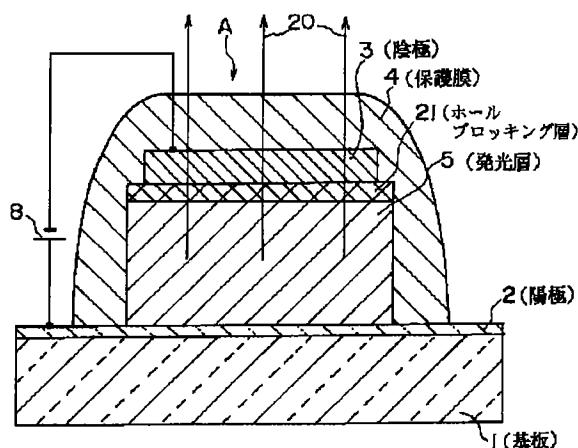
【図3】



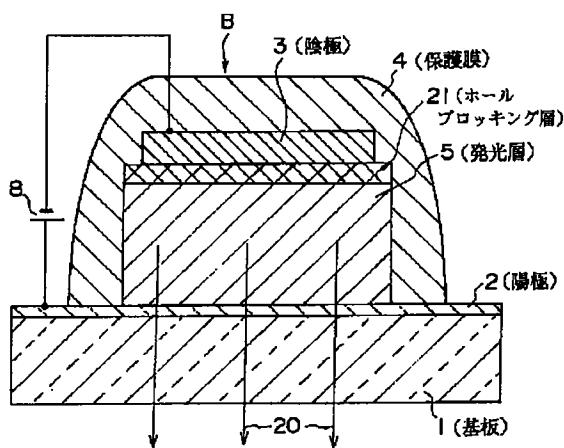
【図4】



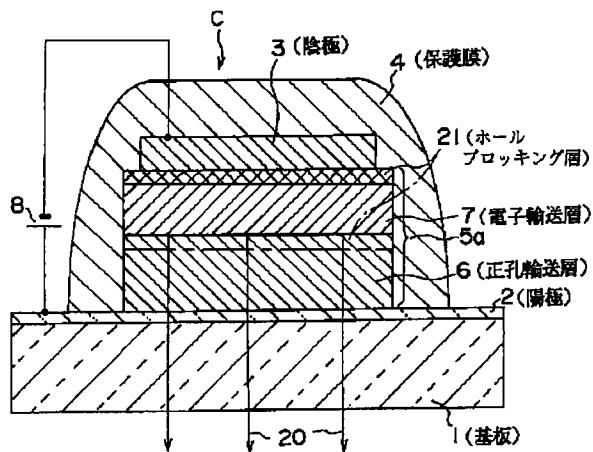
【図5】



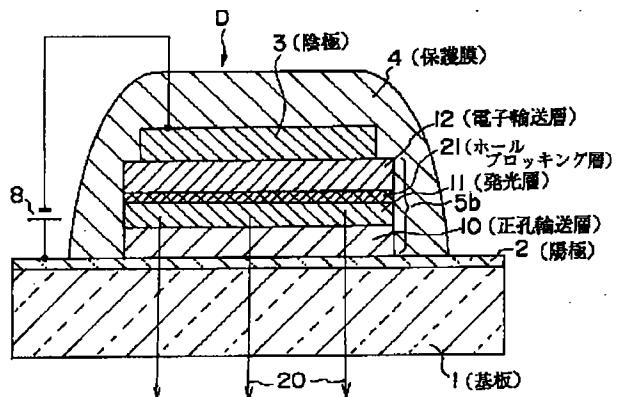
【図6】



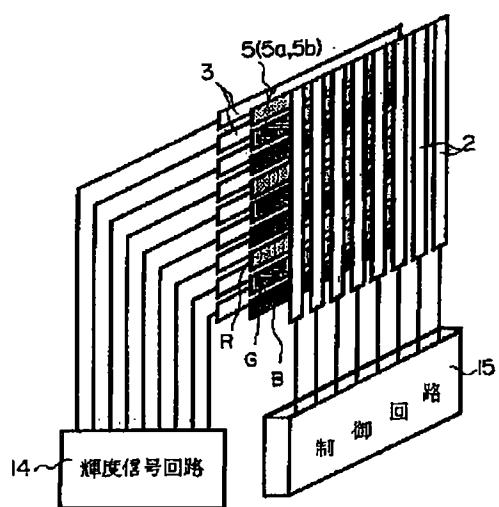
【図7】



【図8】



【図9】



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(72) 発明者 田村 真一郎
東京都品川区北品川6丁目7番35号 ソニ
ー株式会社内

(72) 発明者 植田 尚之
東京都品川区北品川6丁目7番35号 ソニ
ー株式会社内

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(22)Date of filing : 30.10.2000 (72)Inventor : ISHIBASHI TADASHI

ICHIMURA MARI

TAMURA SHINICHIRO

UEDA NAOYUKI

(54) ORGANIC ELECTRIC FIELD LIGHT EMITTING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an organic electric field light emitting device, which has high luminosity and stable red luminescence.

SOLUTION: A mixture containing at least one sort of aminostyryl compound expressed with the following formula [I] or [II] to at least 1 part of an organic layers 5, 5a, or 5b, which have a luminescence domain, is contained. Formula [I]: $Y_1\text{-CH=CH-}X_1\text{-CH=CH-}Y_2$ Formula [II]: $Y_3\text{-CH=CH-}X_2$ However in the formula, X_1 and X_2 express aryl group, such as anthracene group, and Y_1 , Y_2 and Y_3 express arylamino group or the like.

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[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

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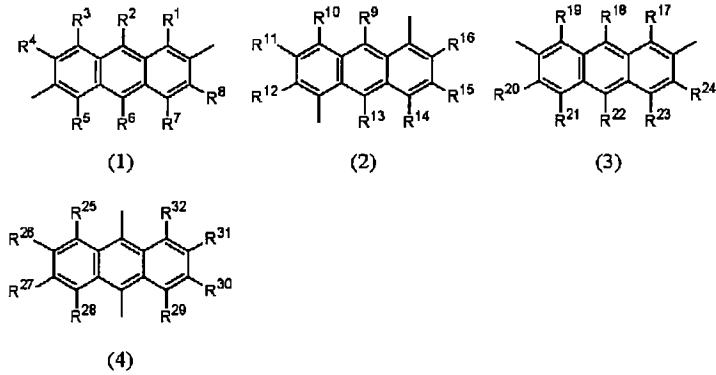
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2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] Organic electroluminescence devices characterized by consisting of mixture with which the at least 1 section of said organic layer contained at least one sort of an amino styryl compound expressed with the following general formula [I] or [II] in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

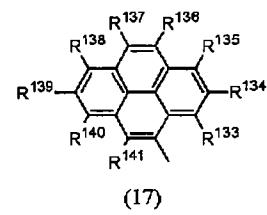
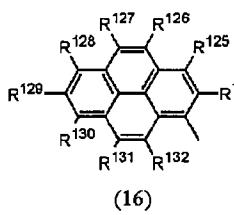
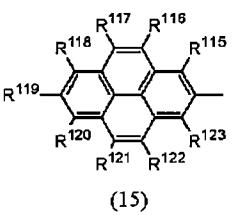
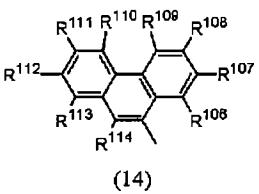
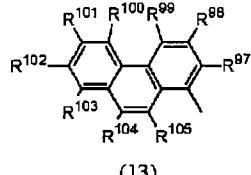
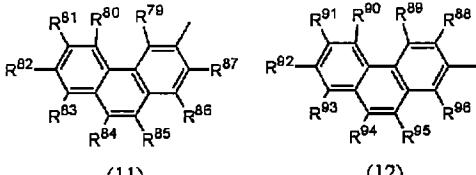
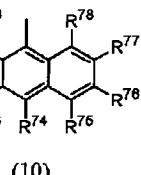
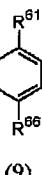
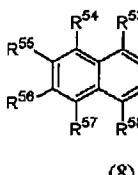
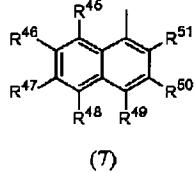
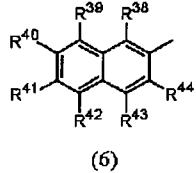
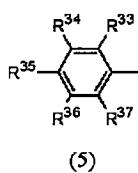
[General-formula I]: It is the radical as which X1 is expressed in either of following general formula (1) - (4) in Y1-CH=CH-X1-CH=CH-Y2 general-formula [II]:Y3-CH=CH-X2[, however said general formula [I], and is [Formula 1].



(However, in each of R1-R8 in said general formula (1) - (4), R9-R16, R17-R24, and R25-R32, at least one is the radical chosen from the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and others are the radicals chosen from a hydrogen atom, an alkyl group, an aryl group, an alkoxy

group, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical.) Moreover, they may be the same or may differ.

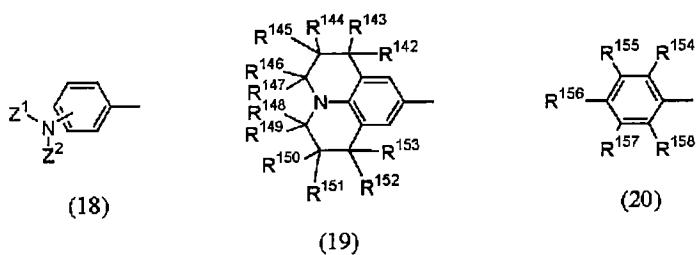
Moreover, it is the radical as which X₂ is expressed in either of following general formula (5) - (17) in said general formula [II], and is [Formula 2].



(However, in said general formula (5) - (17), R33-R141 are the radicals chosen from a hydrogen atom or the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.)

Moreover, Y₁, Y₂, and Y₃ in said general formula [I] and [II] are the radical chosen from the aryl group which may have a hydrogen atom, the alkyl group which may have a substituent, or the substituent expressed with either of following general formula (18) - (20), and its they may be the same or they may differ

[Formula 3]



(However, Z1 and Z2 in said general formula (18) are the radical chosen from the hydrogen atom, the alkyl group which may have a substituent, or the aryl group which may have a substituent, and its they may be the same or they may differ.) Moreover, in said general formula (19) and (20), R142-R158 are the radicals chosen from a hydrogen atom, the alkyl group which may have a substituent, the aryl group which may have a substituent, the alkoxy group which may have a substituent, the halogen atom, the nitro group, the cyano group, and

the trifluoromethyl radical, and its they may be the same or they may differ.]

[Claim 2] Organic electroluminescence devices according to claim 1 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers by which an electron transport layer is expressed at least with said general formula [I] or [II].

[Claim 3] Organic electroluminescence devices according to claim 1 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers by which a hole transportation layer is expressed at least with said general formula [I] or [II].

[Claim 4] Organic electroluminescence devices according to claim 1 which are the mixture layers in which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and said hole transportation layer contained at least one sort of an amino styryl compound expressed with said general formula [I] or [II], and are the mixture layers in which said electron transport layer contained at least one sort of an amino styryl compound expressed with said

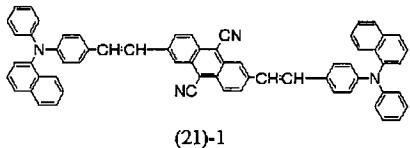
general formula [I] or [II].

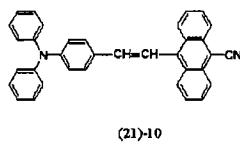
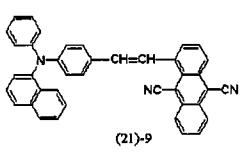
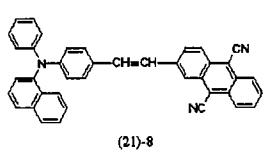
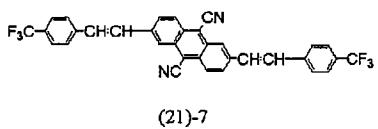
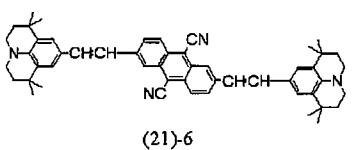
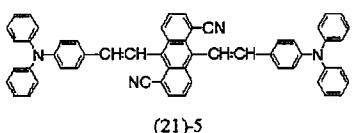
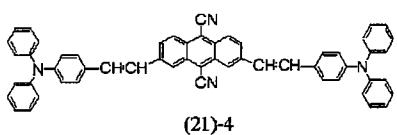
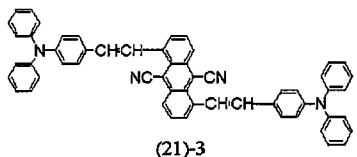
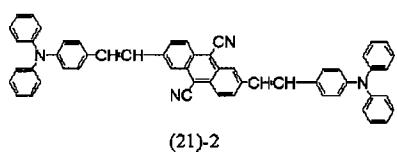
[Claim 5] Organic electroluminescence devices according to claim 1 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers by which a luminous layer is expressed at least with said general formula [I] or [II].

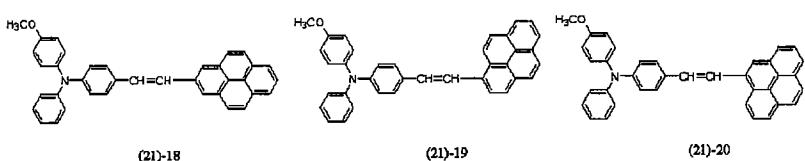
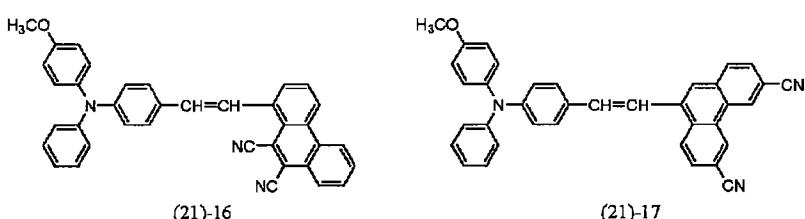
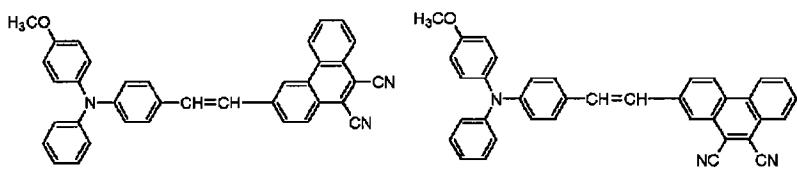
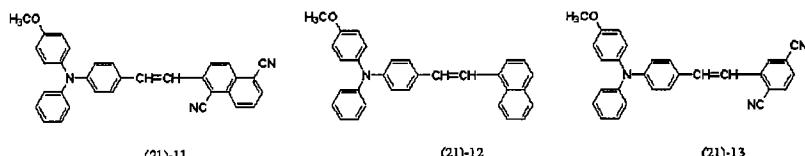
[Claim 6] Organic electroluminescence devices according to claim 1 whose rate of said amino styryl compound in said mixture is 10 - 100 % of the weight.

[Claim 7] Organic electroluminescence devices characterized by consisting of mixture with which the at least 1 section of said organic layer contained at least one sort of the amino styryl compound shown by following structure-expression (21)-1-(21)-20 in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

[Formula 4]







[Claim 8] Organic electroluminescence devices according to claim 7 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers in which an electron transport layer is shown by said structure-expression (21)-1-(21)-20 at least.

[Claim 9] Organic electroluminescence devices according to claim 7 said whose

organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers in which a hole transportation layer is shown by said structure-expression (21)-1-(21)-20 at least.

[Claim 10] Said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It is the mixture layer in which said hole transportation layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And organic electroluminescence devices according to claim 7 which are the mixture layers in which said electron transport layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20.

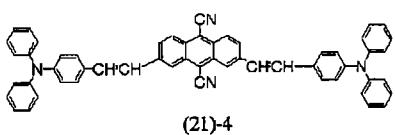
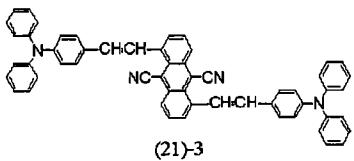
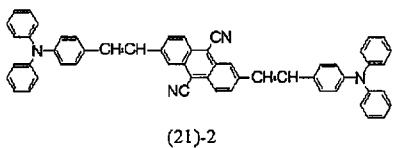
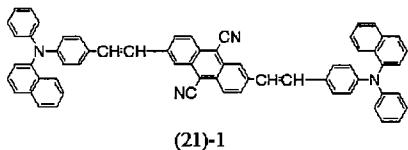
[Claim 11] Organic electroluminescence devices according to claim 7 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers in which a luminous layer is shown by said structure-expression (21)-1-(21)-20 at least.

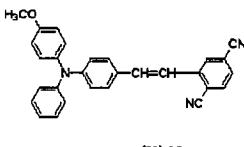
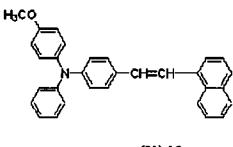
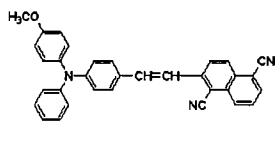
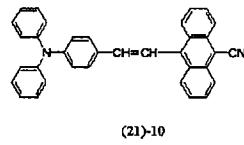
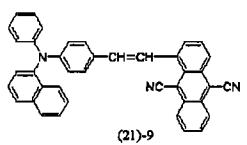
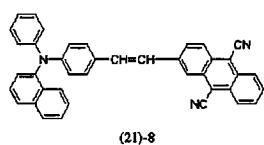
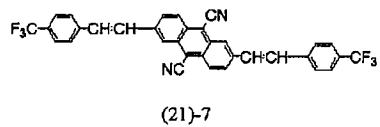
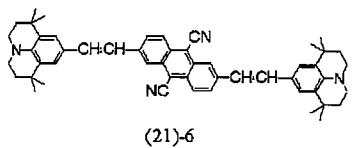
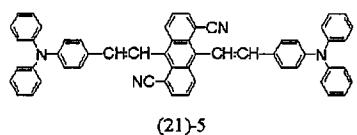
[Claim 12] Organic electroluminescence devices according to claim 7 whose rate

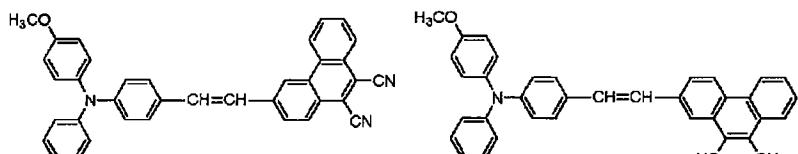
of said amino styryl compound in said mixture is 10 - 100 % of the weight.

[Claim 13] Organic electroluminescence devices to which the at least 1 section of said organic layer is characterized by consisting of mixture containing at least one sort of the amino styryl compound shown by following structure-expression (21)-1-(21)-20, and the red luminescence coloring matter which has the luminescence maximum in the range of 600nm - 700nm in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

[Formula 5]

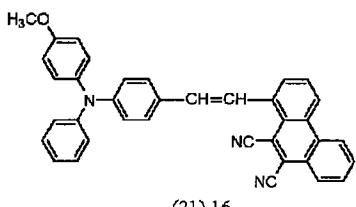




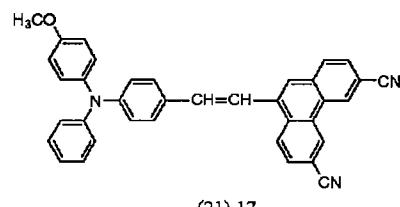


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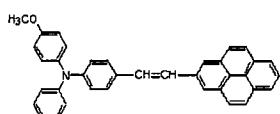
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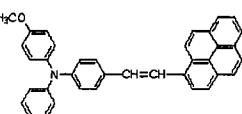
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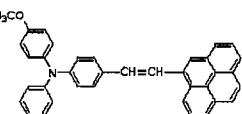
(21)-17



(21)-18



(21)-19



(21)-20

[Claim 14] Organic electroluminescence devices according to claim 13 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers in which an electron transport layer is shown by said structure-expression (21)-1-(21)-20 at least.

[Claim 15] Organic electroluminescence devices according to claim 13 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort of the amino styryl

compound of said organic layers in which a hole transportation layer is shown by said structure-expression (21)-1-(21)-20 at least.

[Claim 16] Said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It is the mixture layer in which said hole transportation layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And organic electroluminescence devices according to claim 13 which are the mixture layers in which said electron transport layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20.

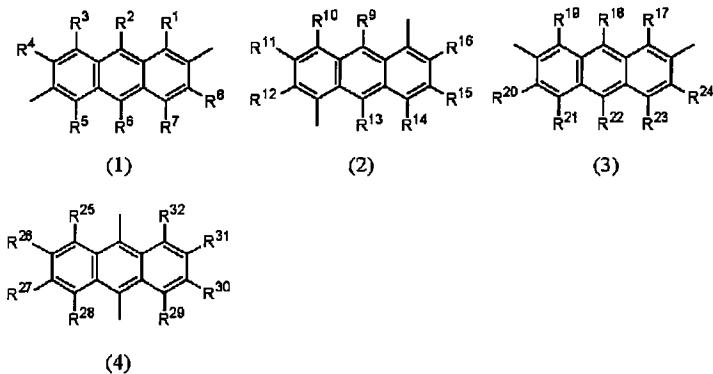
[Claim 17] Organic electroluminescence devices according to claim 13 said whose organic layer is a mixture layer which has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and contained at least one sort of the amino styryl compound of said organic layers in which a luminous layer is shown by said structure-expression (21)-1-(21)-20 at least.

[Claim 18] Organic electroluminescence devices according to claim 13 whose rate of said amino styryl compound in said mixture is 10 - 100 % of the weight.

[Claim 19] Organic electroluminescence devices which consist of mixture with which the at least 1 section of said organic layer contained at least one sort of an

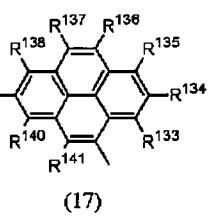
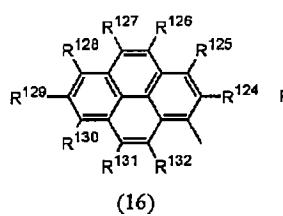
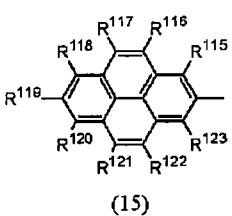
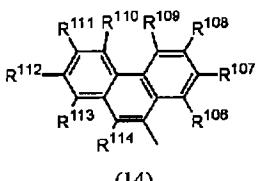
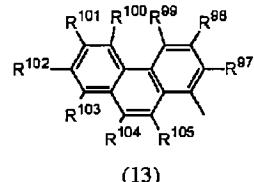
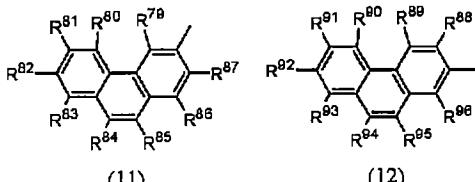
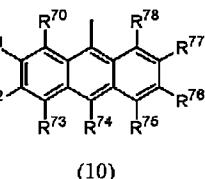
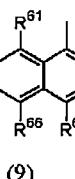
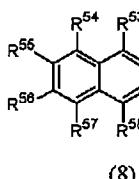
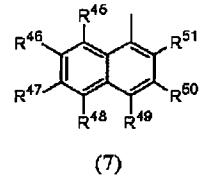
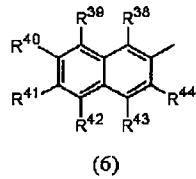
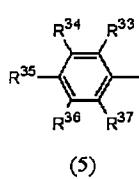
amino styryl compound expressed with the following general formula [I] or [II] in
the organic electroluminescence devices by which the organic layer which has a
luminescence field is prepared between an anode plate and cathode, and are
characterized by a hole blocking layer existing in contact with the cathode side of
the layer which consisted of mixture of a parenthesis.

[General-formula I]: It is the radical as which X1 is expressed in either of following general formula (1) - (4) in Y1-CH=CH-X1-CH=CH-Y2 general-formula [II]:Y3-CH=CH-X2[, however said general formula [I], and is [Formula 6].



(However, in each of R1-R8 in said general formula (1) - (4), R9-R16, R17-R24, and R25-R32, at least one is the radical chosen from the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and others are the radicals chosen from a hydrogen atom, an alkyl group, an aryl group, an alkoxy group, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical.) Moreover, they may be the same or may differ.

Moreover, it is the radical as which X2 is expressed in either of following general formula (5) - (17) in said general formula [II], and is [Formula 7].

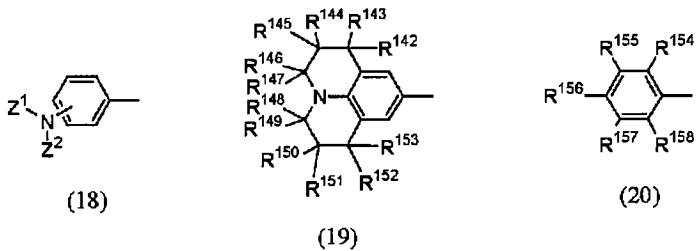


(However, in said general formula (5) - (17), R33-R141 are the radicals chosen from a hydrogen atom or the halogen atom, the nitro group, the cyano group,

and the trifluoromethyl radical, and its they may be the same or they may differ.)

Moreover, Y1, Y2, and Y3 in said general formula [I] and [II] are the radical chosen from the aryl group which may have a hydrogen atom, the alkyl group which may have a substituent, or the substituent expressed with either of following general formula (18) - (20), and its they may be the same or they may differ.

[Formula 8]



(However, Z1 and Z2 in said general formula (18) are the radical chosen from the hydrogen atom, the alkyl group which may have a substituent, or the aryl group which may have a substituent, and its they may be the same or they may differ.) Moreover, in said general formula (19) and (20), R142-R158 are the radicals chosen from a hydrogen atom, the alkyl group which may have a substituent, the aryl group which may have a substituent, the alkoxy group which may have a substituent, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.]

[Claim 20] Organic electroluminescence devices according to claim 19 in which

said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which an electron transport layer is expressed with said general formula [I] or [II] at least, and said hole blocking layer exists in contact with the cathode side of said mixture layer.

[Claim 21] Organic electroluminescence devices according to claim 19 in which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which a hole transportation layer is expressed with said general formula [I] or [II] at least, and said hole blocking layer exists in contact with the cathode side of said mixture layer.

[Claim 22] Said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It is the mixture layer in which said hole transportation layer contained at least one sort of an amino styryl compound expressed with said general formula [I] or [II]. And organic electroluminescence devices according to claim 19 in which it is the mixture layer in which said electron transport layer contained at least one sort of an amino styryl compound expressed with said

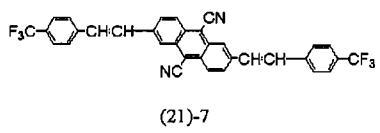
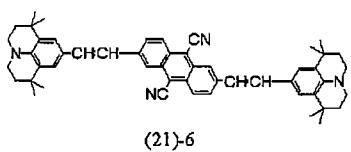
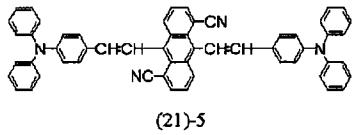
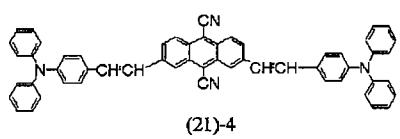
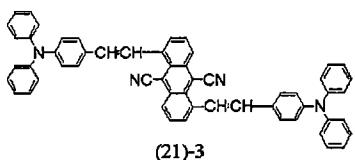
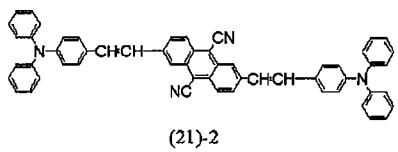
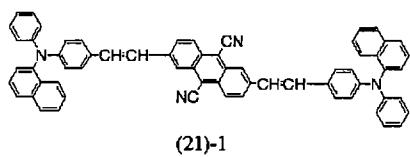
general formula [I] or [II], and said hole blocking layer exists in contact with the cathode side of the electronic transportability luminous layer of a parenthesis.

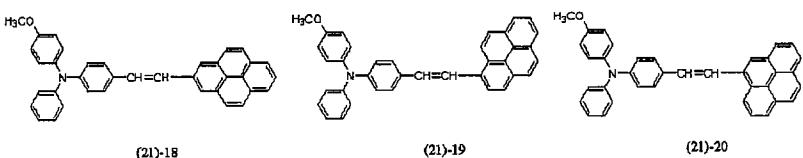
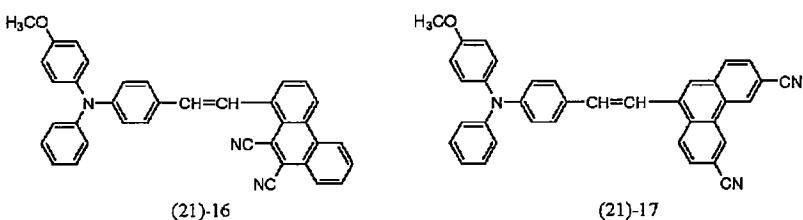
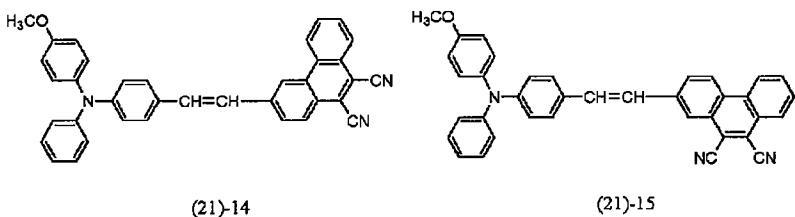
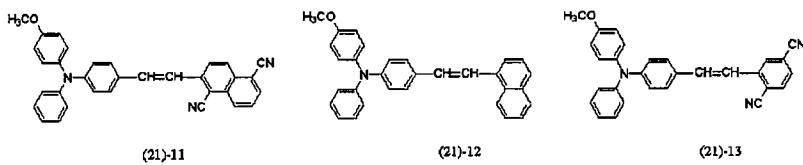
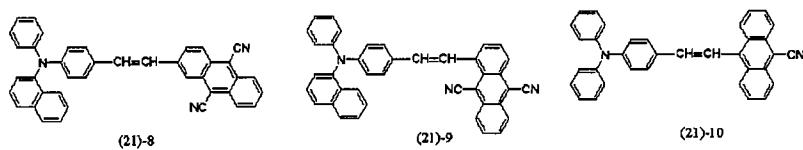
[Claim 23] Organic electroluminescence devices according to claim 19 in which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which said luminous layer is expressed with said general formula [I] or [II] at least, and said hole blocking layer exists in contact with the cathode side of said mixture layer.

[Claim 24] Organic electroluminescence devices according to claim 19 whose rate of said amino styryl compound in said mixture is 10 - 100 % of the weight.

[Claim 25] Organic electroluminescence devices which consist of mixture with which the at least 1 section of said organic layer contained at least one sort of the amino styryl compound shown by following structure-expression (21)-1-(21)-20 in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode, and are characterized by a hole blocking layer existing in contact with the cathode side of the layer which consisted of mixture of a parenthesis.

[Formula 9]





[Claim 26] Organic electroluminescence devices according to claim 25 to which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said

organic layers in which an electron transport layer is shown by said structure-expression (21)-1-(21)-20 at least, and said hole blocking layer exists in a cathode side in contact with said mixture layer.

[Claim 27] Organic electroluminescence devices according to claim 25 to which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers in which a hole transportation layer is shown by said structure-expression (21)-1-(21)-20 at least, and said hole blocking layer exists in a cathode side in contact with said mixture layer.

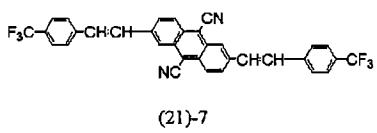
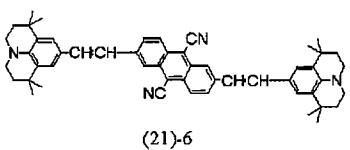
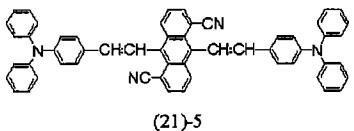
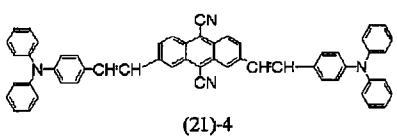
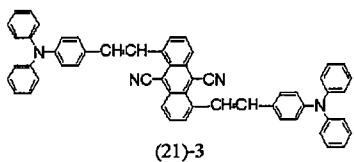
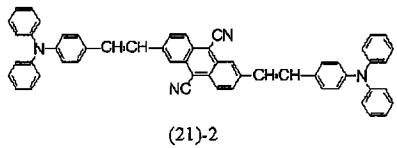
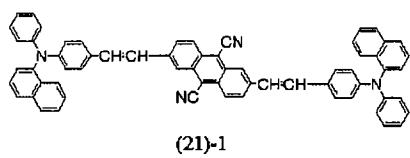
[Claim 28] Said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It is the mixture layer in which said hole transportation layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And it is the mixture layer in which said electron transport layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And organic electroluminescence devices according to claim 25 in which said hole blocking layer exists in contact with the cathode side of this electronic transportability luminous layer.

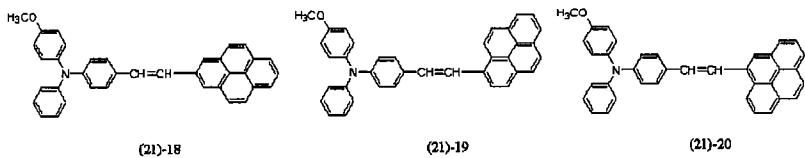
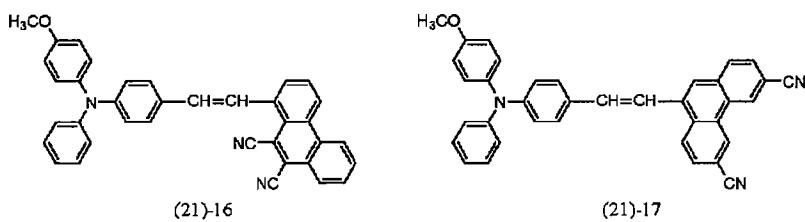
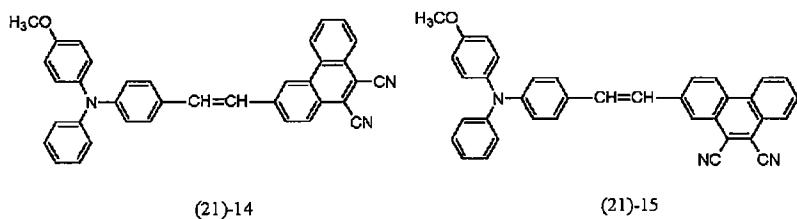
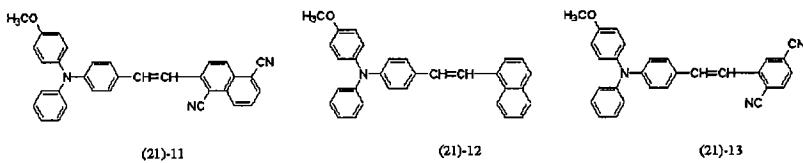
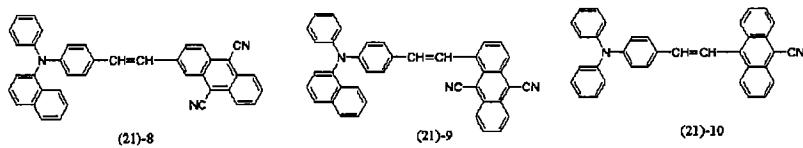
[Claim 29] Organic electroluminescence devices according to claim 25 in which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers said luminous layer is indicated to be by said structure-expression (21)-1-(21)-20 at least, and said hole blocking layer exists in contact with the cathode side of said mixture layer.

[Claim 30] Organic electroluminescence devices according to claim 25 whose rate of said amino styryl compound in said mixture is 10 - 100 % of the weight.

[Claim 31] In the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode At least one sort of the amino styryl compound in which the at least 1 section of said organic layer is shown by following structure-expression (21)-1-(21)-20, Organic electroluminescence devices which consist of mixture containing the red luminescence coloring matter which has the luminescence maximum in the range of 600nm - 700nm, and are characterized by a hole blocking layer existing in contact with the cathode side of the layer which consisted of mixture of a parenthesis.

[Formula 10]





[Claim 32] Organic electroluminescence devices according to claim 31 to which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said

organic layers in which an electron transport layer is shown by said structure-expression (21)-1-(21)-20 at least, and said hole blocking layer exists in a cathode side in contact with said mixture layer.

[Claim 33] Organic electroluminescence devices according to claim 31 to which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers in which a hole transportation layer is shown by said structure-expression (21)-1-(21)-20 at least, and said hole blocking layer exists in a cathode side in contact with said mixture layer.

[Claim 34] Said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. It is the mixture layer in which said hole transportation layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And it is the mixture layer in which said electron transport layer contained at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And organic electroluminescence devices according to claim 31 in which said hole blocking layer exists in contact with the cathode side of this electronic transportability luminous layer.

[Claim 35] Organic electroluminescence devices according to claim 31 in which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, it is a mixture layer containing at least one sort of the amino styryl compound of said organic layers said luminous layer is indicated to be by said structure-expression (21)-1-(21)-20 at least, and said hole blocking layer exists in contact with the cathode side of said mixture layer.

[Claim 36] Organic electroluminescence devices according to claim 31 whose rate of said amino styryl compound in said mixture is 10 - 100 % of the weight.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the organic electroluminescence devices (organic EL device) by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

[0002]

[Description of the Prior Art] The lightweight and efficient flat-panel display is

briskly studied and developed as an object for the screen display of a computer or television.

[0003] first -- although brightness of the Braun tube (CRT) is high, and it is used most mostly as a current display since color reproduction nature is good -- ** -- it is high and power consumption also has heavily the problem of being high.

[0004] Moreover, liquid crystal displays, such as an active-matrix drive, are commercialized as a lightweight and efficient flat-panel display. However, the angle of visibility of a liquid crystal display is narrow, and since it is not spontaneous light, it has the trouble of not having sufficient response engine performance to that the power consumption of a back light is large, and the high-speed video signal of a high definition with which utilization will be expected from now on under an environment dark in a perimeter. Technical problems, like especially the thing for which the display of big screen size is manufactured is difficult, and the cost is high also occur.

[0005] Although there is possibility of the display using the light emitting diode as an alternative over this, too, a manufacturing cost is high and the technical problem to utilization is large as a display candidate of a low price who there are problems, like it is difficult to form the matrix structure of a light emitting diode on the substrate whose number is one, and replaces the Braun tube.

[0006] Organic electroluminescence devices (organic EL device) using an

organic luminescent material as a flat-panel display which may solve many of these technical problems attract attention recently. That is, by using an organic compound as a luminescent material, a speed of response is high-speed with spontaneous light, and implementation of a flat-panel display without an angle-of-visibility dependency is expected.

[0007] The configuration of organic electroluminescence devices forms the organic thin film containing the luminescent material which emits light by impregnation of a current between the positive electrode of translucency, and metal cathode. C. W.Tang, S.A.VanSlyke, etc. In the research report of the 51st-volume No. 12 Applied Physics Letters 913-915-page (1987) printing The component structure which emits light when the hole and electron which were poured in into the organic film from each electrode recombine an organic thin film as two-layer structure of the thin film which consists of an electron hole transportability ingredient, and the thin film which consists of an electronic transportability ingredient was developed (organic EL device of single hetero structure).

[0008] With this component structure, either the electron hole transportation ingredient or the electronic transportation ingredient serves as luminescent material, and luminescence occurs by the wavelength range corresponding to the energy gap of the ground state and excitation state of luminescent material.

By considering as such two-layer structure, reduction of large driver voltage and an improvement of luminous efficiency were made.

[0009] Then, C.Adachi, S.Tokita, T.Tsutsui, S.Saito etc. As indicated by the research report of Japanese Journal of Applied Physics volume [27th] No. 2 L269-L 271-page (1988) printing The three-tiered structure (organic EL device of double hetero structure) of an electron hole transportation ingredient, luminescent material, and an electronic transportation ingredient is developed. Furthermore, C.W.Tang, S.A.VanSlyke, C.H.Chen, etc. Journal of Applied Physics As indicated by the research report of the 65th-volume No. 9 3610-3616-page (1989) printing The component structure where luminescent material was included in the electronic transportation ingredient etc. was developed. By these researches, by the low battery, the possibility of luminescence of high brightness is verified and researches and developments are done very actively in recent years.

[0010] It can be said that there is an organic compound used for luminescent material about the advantage that the luminescent color is theoretically changeable into arbitration by changing the molecular structure from the versatility. Therefore, it can be said to be easy by performing a molecular design compared with the thin film EL element which used the inorganic substance to arrange three good colors of R (red), G (green), and B (blue) of color purity

required for a full color display.

[0011]

[Problem(s) to be Solved by the Invention] However, also in organic electroluminescence devices, there is a problem which must be solved in fact. As an electronic transportation ingredient by which is difficult for development of the stable red light emitting device of high brightness, and the current report is carried out tris (eight quinolinol) aluminum (the following, Alq₃, and an abbreviated name --) the example (Chem.Funct.Dyes, Proc.Int.Symp., 2nd P.536 (1993), etc. -- also setting -- the highest brightness --) of red luminescence

which doped DCM [a
4-dicyanomethylene-6-(p-dimethylaminostyryl)-2-methyl-4H-pyran] The
satisfaction as a display ingredient of dependability does not go.

[0012] Moreover, T.Tsutsui and D.U.Kim Inorganic and Organic electroluminescence BSB-BCN reported at the meeting (1996 Berlin) is 1000 cd/m². Although the above high brightness is realized, it cannot be said to be what has a perfect chromaticity as red which corresponds in full color.

[0013] The present condition is that implementation of stability and the high red light emitting device of color purity is furthermore desired by high brightness.

[0014] Moreover, in JP,7-188649,A (Japanese Patent Application No. No. 148798 [six to]), although it has proposed using a specific JISUCHIRIRU

compound as an organic electroluminescence ingredient, the target luminescent color is blue and it is not an object for red. on the other hand, a hole and an electron join together efficiently in a luminous layer by [of a hole and an electron / energy] shutting up and making structure in the laminated structure of organic electroluminescence devices, and it is reported that pure luminescence original with high brightness and luminescent material can be obtained -- **** (JP,10-79297,A, JP,11-204258,A, JP,11-204264,A, JP,11-204259,A, etc.) -- the target luminescent color is blue too and is not an object for red.

[0015] The purpose of this invention is to offer the organic electroluminescence devices which have high brightness and stable red or red Mr. luminescence.

[0016] The second purpose of this invention promotes the hole in a luminous layer, and electronic recombination in the organic electroluminescence devices containing the mixture containing the compound of this invention which has a fluorescence yield high originally and was excellent also in thermal stability, and is to offer the organic electroluminescence devices which present further high brightness and efficient luminescence.

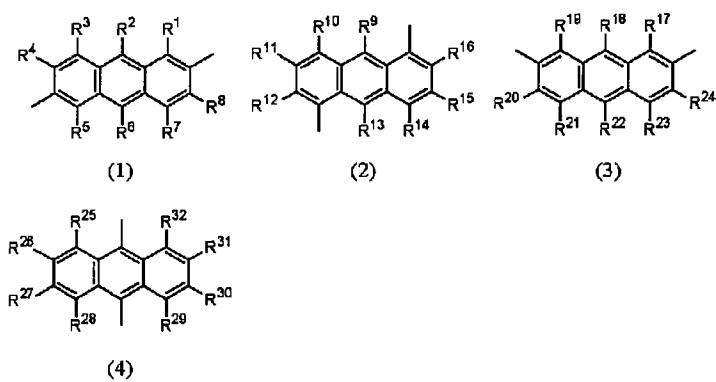
[0017]

[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, as a result of inquiring wholeheartedly, a header and this invention are reached [that the stable full color display

implementation of high brightness can be provided with the red light emitting device of very useful high-reliability, and] by using a specific styryl compound and mixture with the ingredient which can transmit energy efficiently as a luminescent material.

[0018] That is, this invention relates to the organic electroluminescence devices characterized by consisting of mixture with which the at least 1 section of said organic layer contained at least one sort of an amino styryl compound expressed with the following general formula [I] or [II] in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode.

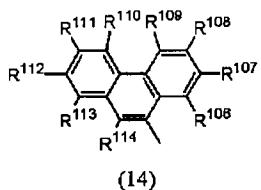
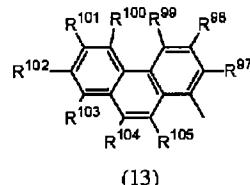
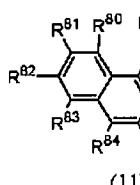
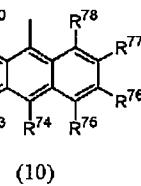
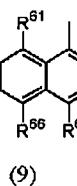
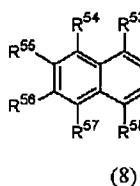
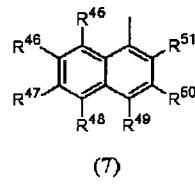
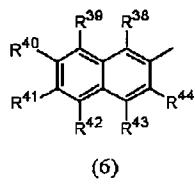
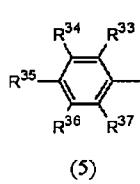
[General-formula I]: It is the radical as which X1 is expressed in either of following general formula (1) - (4) in Y1-CH=CH-X1-CH=CH-Y2 general-formula [II]:Y3-CH=CH-X2[, however said general formula [I], and is [Formula 11].

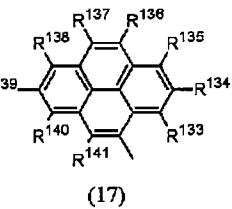
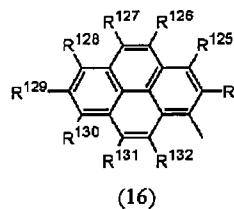
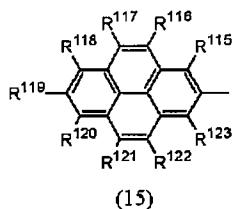


(However, it sets to each of R1-R8 in said general formula (1) - (4), R9-R16,

R17-R24, and R25-R32.) At least one A halogen atom (for example, below : a fluorine, chlorine, etc. are the same), It is the radical chosen from the nitro group, the cyano group, and the trifluoromethyl radical, and others are the radicals chosen from a hydrogen atom, an alkyl group, an aryl group, an alkoxy group, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical. Moreover, they may be the same or may differ.

Moreover, it is the radical as which X2 is expressed in either of following general formula (5) - (17) in said general formula [II], and is [Formula 12].

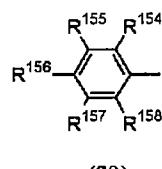
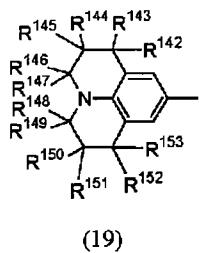
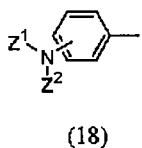




(However, in said general formula (5) - (17), R33-R141 are the radicals chosen from a hydrogen atom or the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.)

Moreover, Y1, Y2, and Y3 in said general formula [I] and [II] are the radical chosen from the aryl group which may have a hydrogen atom, the alkyl group which may have a substituent, or the substituent expressed with either of following general formula (18) - (20), and its they may be the same or they may differ.

[Formula 13]



(However, Z1 and Z2 in said general formula (18) are the radical chosen from the hydrogen atom, the alkyl group which may have a substituent, or the aryl

group which may have a substituent, and its they may be the same or they may differ.) Moreover, in said general formula (19) and (20), R142-R158 are the radicals chosen from a hydrogen atom, the alkyl group which may have a substituent, the aryl group which may have a substituent, the alkoxy group which may have a substituent, the halogen atom, the nitro group, the cyano group, and the trifluoromethyl radical, and its they may be the same or they may differ.]

[0019] At least one sort of an amino styryl compound expressed in the above-mentioned general formula [I] as the above "mixture" here, At least one sort of an amino styryl compound expressed with mixture [with the compound of others which have a property advantageous to attaining the purpose of this invention];, or the above-mentioned general formula [II], Mixture with the compound of others which have a property advantageous to attaining the purpose of this invention; At least one sort of an amino styryl compound further expressed with the above-mentioned general formula [I], At least one sort of an amino styryl compound expressed with at least 1 sort of mixture; or the above-mentioned general formula [I] of the amino styryl compound expressed with the above-mentioned general formula [II], The mixture of at least one sort of an amino styryl compound expressed with the above-mentioned general formula [III] and the compound of others which have a property advantageous to attaining the purpose of this invention is meant.

[0020] This invention can offer the component which was chemically [electrically, thermally, or] excellent in stability while stable red luminescence is obtained by high brightness, since the mixture containing at least one sort of an amino styryl compound expressed with the above-mentioned general formula [I] or [II] is used for luminescent material.

[0021] An ingredient usable in order to form the mixture based on this invention containing the amino styryl compound expressed with the above-mentioned general formula [I] used for this invention, or [II] Although it should not be limited especially, for example besides the amino styryl compound expressed with the above-mentioned general formula [I] of this invention, or [II] Hole transportation ingredients (for example, aromatic amine etc.), an electronic transportation ingredient For example, a series of (Alq3, pyrazolines, compounds), etc. generally used as a dopant for red luminescence (DCM and its analogue, porphyrins, phthalocyanines, a perylene compound, the Nile red, squarylium compound, etc.) etc. are mentioned.

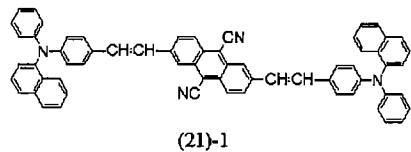
[0022] While becoming possible to aim at improvement in electron hole transportability ability, charge transportability ability, or the luminescence engine performance by using as a formation ingredient of the mixture containing the amino styryl compound express with the above-mentioned general formula [I] or [II] in each compound which carried out [above-mentioned] instantiation based

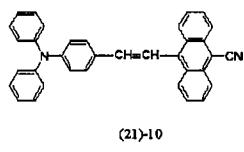
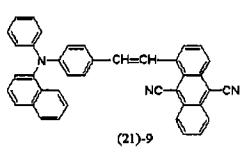
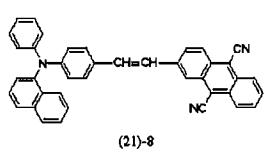
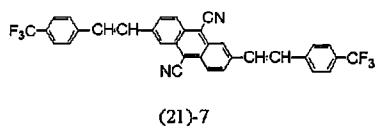
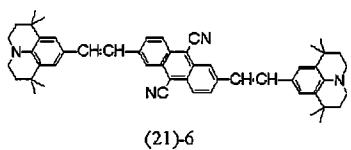
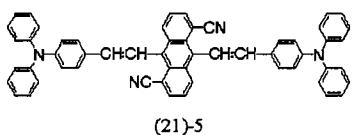
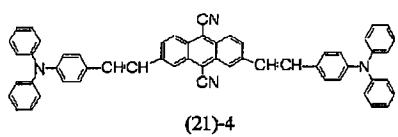
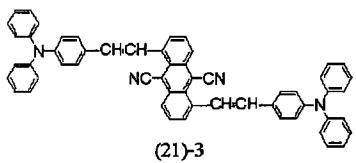
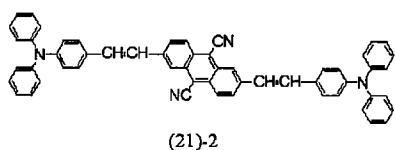
on this invention and obtaining stable red luminescence by high brightness more, it can consider as the component which was further excellent also electrically, thermally, or chemically.

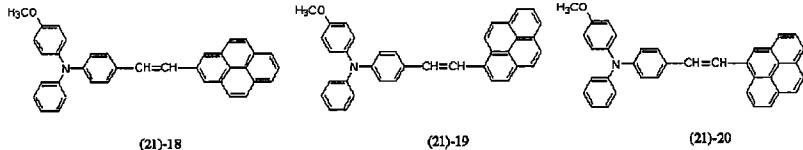
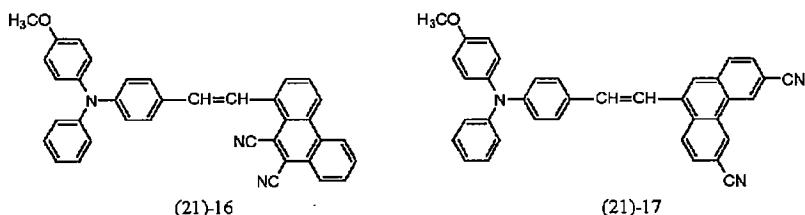
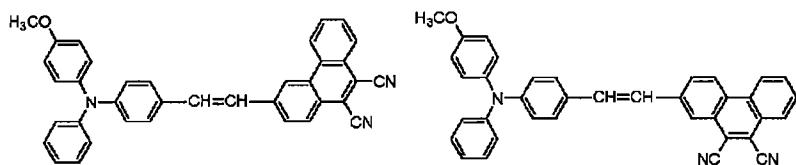
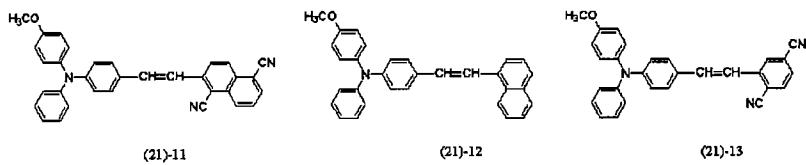
[0023] in the amino styryl compound expressed with the above-mentioned general formula [I] used for this invention, or [II], although the above X1 (the above-mentioned general formula (1) - (4)) and the above X2 (the above-mentioned general formula (5) - (17)) are important when the luminescent material used for this invention produces red luminescence, the number of the benzene rings increases, for example -- alike -- following -- the luminescence wavelength of an organic luminescent material -- a long wave -- there is an inclination shifted to a merit side.

[0024] In the organic electroluminescence devices of this invention, the amino styryl compound shown by the above-mentioned general formula [I] and the above-mentioned general formula [II] which are luminescent material has an usable kind, even if there is little molecular structure like following structure-expression (21)-1-(21)-20.

[Formula 14]







[0025] In order to solve the above-mentioned technical problem, as a result of inquiring wholeheartedly again, this invention person used to produce the organic electroluminescence devices which constituted the at least 1 section of an organic layer which has a luminescence field from mixture containing a specific amino styryl compound and specific red luminescence coloring matter, and used to reach this invention which offers the component of high brightness and high-reliability further.

[0026] Namely, this invention is set to the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode. At least one sort of the amino styryl compound in which the at least 1 section of said organic layer is shown by the above-mentioned structure-expression (21)-1-(21)-20, It is involved in the organic electroluminescence devices characterized by consisting of mixture containing the red luminescence coloring matter which has the luminescence maximum in the range of 600nm - 700nm.

[0027] Especially if the above-mentioned red luminescence coloring matter is the compound which has the luminescence maximum in the range of 600nm - 700nm, it should not be limited, but as mentioned above, a series of compounds (DCM and its analogue, porphins, phthalocyanines, a perylene compound, the Nile red, squarylium compound, etc.) generally used as a dopant for red luminescence are mentioned.

[0028] By including the above-mentioned red luminescence coloring matter, the luminescence engine performance can be improved more and stable red luminescence can be further obtained by high brightness.

[0029] This invention may be the mixture layer which said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and contained at least one sort

of the amino styryl compound of said organic layers to which an electron transport layer is expressed with said general formula [I] or [II] at least, or the amino styryl compound shown by said structure-expression (21)-1-(21)-20, for example.

[0030] Moreover, said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and may be a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which a hole transportation layer is expressed with said general formula [I] or [II] at least, or the amino styryl compound shown by said structure-expression (21)-1-(21)-20.

[0031] Moreover, said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out. The amino styryl compound by which said hole transportation layer is expressed with the above-mentioned general formula [I] or [II], Or it is a mixture layer containing at least one sort of the amino styryl compound shown by said structure-expression (21)-1-(21)-20. And said electron transport layer may be a mixture layer containing at least one sort of the amino styryl compound expressed with the above-mentioned general formula [I] or [II], or the amino styryl compound shown by said structure-expression (21)-1-(21)-20.

[0032] Moreover, said organic layer has the organic laminated structure to which

the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and may be a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which a luminous layer is expressed with said general formula [I] or [II] at least, or the amino styryl compound shown by said structure-expression (21)-1-(21)-20.

[0033] As for this invention, it is still more desirable that it is [of said amino styryl compound in said mixture] 10 - 100 % of the weight comparatively.

[0034] Moreover, in the organic electroluminescence devices containing the mixture containing the compound of above-mentioned this invention which has a fluorescence yield high originally and was excellent also in thermal stability, by putting a hole (electron hole) blocking layer on the cathode side of a luminous layer, recombination of a hole and an electron is efficiently performed in a luminous layer, and this invention comes to offer the organic electroluminescence devices from which pure luminescence original with luminescent material is obtained high brightness and efficient.

[0035] Namely, this invention is set to the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode again. The amino styryl compound by which the at least 1 section of said organic layer is expressed with said general formula [I] or [II], Or mixture (the red luminescence coloring matter which has the

luminescence maximum in 600nm - the above mentioned 700nm may be contained in this mixture.) containing at least one sort of the amino styryl compound (following, the same) shown by said structure-expression (21)-1-(21)-20 : It consists of being the same hereafter and is involved in the organic electroluminescence devices characterized by a hole blocking layer existing in contact with the cathode side of the layer which consisted of mixture of a parenthesis.

[0036] For example, said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and said hole blocking layer is able to be a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which an electron transport layer is expressed with said general formula [I] or [II] at least, and to exist in contact with the cathode side of said mixture layer.

[0037] Moreover, said organic layer has the organic laminated structure to which the laminating of a hole transportation layer and the electron transport layer was carried out, and said hole blocking layer is able to be a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which a hole transportation layer is expressed with said general formula [I] or [II] at least, and to exist in contact with the cathode side of said mixture layer.

[0038] Moreover, said organic layer has the organic laminated structure to which

the laminating of a hole transportation layer and the electron transport layer was carried out. It is the mixture layer in which said hole transportation layer contained at least one sort of an amino styryl compound expressed with said general formula [I] or [II]. And it is the mixture layer in which said electron transport layer contained at least one sort of an amino styryl compound expressed with said general formula [I] or [II], and said hole blocking layer is able to exist in contact with the cathode side of the electronic transportability luminous layer of a parenthesis.

[0039] Moreover, said organic layer has the organic laminated structure to which the laminating of a hole transportation layer, a luminous layer, and the electron transport layer was carried out, and said hole blocking layer is able to be a mixture layer containing at least one sort of the amino styryl compound of said organic layers to which said luminous layer is expressed with said general formula [I] or [II] at least, and to exist in contact with the cathode side of said mixture layer.

[0040] Furthermore, it is desirable that the rate of said amino styryl compound in said mixture is 10 - 100 % of the weight.

[0041] Moreover, it is desirable for the ingredient suitable for a hole blocking layer to be what has the following energy states. Namely, the thing in energy level with the highest occupancy molecular-orbital level of the ingredient which

forms a hole blocking layer lower than the highest occupancy molecular-orbital level of the ingredient which forms the layer which touches the anode plate side of a hole blocking layer. In addition, and the minimum non-occupying molecular-orbital level of the ingredient which forms a hole blocking layer It is being in energy level lower than the minimum non-occupying molecular-orbital level of the ingredient which forms the layer which is in energy level higher than the minimum non-occupying molecular-orbital level of the ingredient which forms the layer which touches the anode plate side of a hole blocking layer, and touches the cathode side of a hole blocking layer.

[0042] Although the phenanthroline derivative shown in JP,10-79297,A, JP,11-204258,A, JP,11-204264,A, JP,11-204259,A, etc. is mentioned as such an ingredient, if the conditions of the above-mentioned energy level are fulfilled, it will not be limited to a phenanthroline derivative.

[0043] Drawing 1 - drawing 4 and drawing 5 - drawing 8 show the example of organic electroluminescence devices based on this invention, respectively.

[0044] Drawing 1 is the transparency mold organic electroluminescence devices A to which the luminescence light 20 penetrates cathode 3, and the luminescence light 20 can be observed also from a protective layer 4 side.

Drawing 2 shows the reflective mold organic electroluminescence devices B which also obtain the reflected light in cathode 3 as a luminescence light 20.

[0045] Among drawing, one is a substrate for forming organic electroluminescence devices, and can use glass, plastics, and other proper ingredients. Moreover, a substrate can also be shared when using organic electroluminescence devices combining other display devices. 2 -- a transparent electrode (anode plate) -- it is -- ITO (Indium tin oxide) and SnO₂ etc. -- it can be used.

[0046] Moreover, 5 is an organic luminous layer and contains the mixture containing the above-mentioned amino styryl compound as a luminescent material. About this luminous layer, well-known various configurations can be conventionally used as lamination which obtains organic electroluminescence 20. When the ingredient which constitutes an electron hole transportation layer or an electron transport layer has a luminescence so that it may mention later for example, the structure which carried out the laminating of these thin films can be used. Furthermore, in order to raise charge transportability ability in the range which fills the purpose of this invention, both an electron hole transportation layer, and both [either or] bar using the structure which carried out the laminating of the thin film of two or more sorts of ingredients, or the thin film which consists of a presentation which mixed two or more sorts of ingredients. Moreover, in order to improve the luminescence engine performance, the ingredient of at least one or more sorts of fluorescence may be used, and the

structure which pinched this thin film between the electron hole transportation layer and the electron transport layer, and the structure where the ingredient of at least one or more sorts of fluorescence was further included in an electron hole transportation layer, electron transport layers, or these both may be used. In order to improve luminous efficiency in these cases, it is also possible to include the thin film for controlling transportation of an electron hole or an electron in the lamination.

[0047] For example, since the amino styryl compound illustrated with the above-mentioned structure expression (21) has both electronic transportability ability and electron hole transportability ability, it can be used also as a luminous layer which consists of mixture containing the above-mentioned amino styryl compound which served both as the electron transport layer during the component configuration, which consists of mixture containing the above-mentioned amino styryl compound, and which served as the electron hole transportation layer also as a luminous layer. Moreover, it is also possible to consider as the configuration put in the electron transport layer and the electron hole transportation layer by making mixture containing this amino styryl compound into a luminous layer. In addition to the above-mentioned configuration, drawing 5 and drawing 6 form the hole blocking layer 21 which consists of a phenanthroline derivative in contact with the cathode side of a

luminous layer 5.

[0048] In addition, among drawing 1 and drawing 2 , drawing 5 , and drawing 6 , three are cathode and can use the alloy of a metal [activity / calcium / Li, Mg,] and metals, such as Ag, aluminum, and In, or the structure which carried out the laminating of these as an electrode material. In the organic electroluminescence devices of a transparency mold, the light transmittance suitable for an application can be obtained by adjusting the thickness of cathode. Moreover, four in drawing is the closure and a protective layer, and the effectiveness goes up it by making the organic whole electroluminescence devices into wrap structure. A proper ingredient can be used if airtightness is maintained. Moreover, 8 is a drive power source for current impregnation.

[0049] In the organic electroluminescence devices based on this invention, the organic layer has the organic laminated structure (single hetero structure) to which the laminating of an electron hole transportation layer and the electron transport layer was carried out, and the mixture which contained said amino styryl compound as a formation ingredient of an electron hole transportation layer or an electron transport layer may be used. Or the organic layer has the organic laminated structure (double hetero structure) to which the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer was carried out one by one, and the mixture which contained said

styryl compound as a formation ingredient of a luminous layer may be used.

[0050] When the example of the organic electroluminescence devices which have such an organic laminated structure is shown, drawing 3 has the laminated structure to which the laminating of organic layer 5a which consists of an anode plate 2, and the electron hole transportation layer 6 and electron transport layer 7 of translucency on the substrate 1 of translucency, and the cathode 3 was carried out one by one, and is the organic electroluminescence devices C of the single hetero structure where a protective coat 4 comes to carry out the closure of this laminated structure. In drawing 7, the hole blocking layer 21 is formed in contact with the cathode side of an electron transport layer 7 and/or the electron hole transportation layer 6.

[0051] In the case of the lamination which omitted the luminous layer as shown in drawing 3 and drawing 7, the luminescence 20 of predetermined wavelength is generated from the interface of the electron hole transportation layer 6 and an electron transport layer 7. These luminescence is observed from a substrate 1 side.

[0052] Moreover, drawing 4 has the laminated structure to which the laminating of organic layer 5b which consists of an anode plate 2, and the electron hole transportation layer 10, the luminous layer 11 and electron transport layer 12 of translucency on the substrate 1 of translucency, and the cathode 3 was carried

out one by one, and is the organic electroluminescence devices D of the double hetero structure where a protective coat 4 comes to carry out the closure of this laminated structure. In drawing 8, the hole blocking layer 21 is formed in contact with the cathode side of a luminous layer 11.

[0053] In the organic electroluminescence devices shown in drawing 4, the electron with which the electron hole poured in from the anode plate 2 was poured in from cathode 3 through the electron hole transportation layer 10 reaches a luminous layer 11 through an electron transport layer 12, respectively by impressing direct current voltage between an anode plate 2 and cathode 3. Consequently, the recombination of an electron/electron hole arises in a luminous layer 11, a singlet exciton generates, and luminescence of predetermined wavelength is generated from this singlet exciton.

[0054] In each organic electroluminescence devices C and D mentioned above, the ingredient of light transmission nature, such as glass and plastics, can be suitably used for a substrate 1. Moreover, when using combining other display devices, or when arranging the laminated structure shown in drawing 3 and drawing 4, drawing 7, and drawing 8 in the shape of a matrix, it is good considering this substrate as common use. Moreover, Components C and D can all take any structure of a transparency mold and a reflective mold.

[0055] moreover, the anode plate 2 -- a transparent electrode -- it is -- ITO

(indium tin oxide) and SnO₂ etc. -- it can be used. Between this anode plate 2 and the electron hole transportation layer 6 (or electron hole transportation layer 10), the thin film which consists of the organic substance or an organometallic compound may be prepared in order to improve the injection efficiency of a charge. In addition, when the protective coat 4 is formed with conductive ingredients, such as a metal, the insulator layer may be prepared in the side face of an anode plate 2.

[0056] Moreover, the electron hole transportation layer 6 and an electron transport layer 7 are organic layers by which the laminating was carried out, the mixture containing the amino styryl compound described above to these either or both sides contains organic layer 5a in the organic electroluminescence devices C, and it is good as the luminescent electron hole transportation layer 6 or a luminescent electron transport layer 7. Organic layer 5b in the organic electroluminescence devices D can take various laminated structures, although the electron hole transportation layer 10, the luminous layer 11 containing the mixture containing the above-mentioned amino styryl compound, and an electron transport layer 12 are organic layers by which the laminating was carried out. For example, both the electron hole transportation layer, and both [either or] may have a luminescence.

[0057] Moreover, in an electron hole transportation layer, in order to raise

electron hole transportability ability, the electron hole transportation layer which carried out the laminating of two or more sorts of electron hole transportation ingredients may be formed.

[0058] Moreover, in the organic electroluminescence devices C, although a luminous layer may be the electronic transportability luminous layer 7, depending on the electrical potential difference impressed from a power source 8, light may be emitted by the electron hole transportation layer 6 or its interface. Similarly, in the organic electroluminescence devices D, a luminous layer may be an electron transport layer 12 in addition to layer 11, and may be the electron hole transportation layer 10. In order to raise the luminescence engine performance, it is good that it is the structure where the luminous layer 11 which used at least one sort of fluorescence ingredients was made to pinch between an electron hole transportation layer and an electron transport layer. Or the structure where an electron hole transportation layer, an electron transport layer, or both [these] layers were made to contain this fluorescence ingredient may be constituted. In such a case, in order to improve luminous efficiency, it is also possible to include the thin films (a hole blocking layer, exciton generation layer, etc.) for controlling transportation of an electron hole or an electron in the lamination.

[0059] Moreover, you may be the structure in which could use the alloy of a

metal [activity / calcium / Li, Mg,] and metals, such as Ag, aluminum, and In, as an ingredient used for cathode 3, and these metal layers carried out the laminating. In addition, the organic electroluminescence devices corresponding to an application are producible by choosing the thickness and the quality of the material of cathode suitably.

[0060] Moreover, a protective coat 4 acts as closure film, is making the organic whole electroluminescence devices into wrap structure, and can improve charge injection efficiency and luminous efficiency. In addition, if the airtightness is maintained, a single metal or alloys, such as aluminum, gold, and chromium, etc. can choose the ingredient suitably.

[0061] Although the current impressed to each above-mentioned organic electroluminescence devices is usually a direct current, pulse current and an alternating current may be used. If a current value and an electrical-potential-difference value are within the limits which does not carry out component destruction, there will be especially no limit, but when the power consumption and the life of organic electroluminescence devices are taken into consideration, it is desirable to make light emit efficiently with as small electrical energy as possible.

[0062] Next, drawing 9 is the example of a configuration of the flat-surface display which used the organic electroluminescence devices of this invention. In

the full color display, like illustration, red (R) and the green organic layer 5 (5a, 5b) which can emit light in the three primary colors of (G) and blue (B) are allotted between cathode 3 and an anode plate 2. It can prepare in the shape of [which crosses mutually] a stripe, it is chosen by the luminance-signal circuit 14 and the control circuit 15 with a built-in shift register, and a signal level is impressed to each, and cathode 3 and an anode plate 2 are constituted so that the organic layer of the location (pixel) where the cathode 3 and the anode plate 2 which were chosen by this cross may emit light.

[0063] That is, it is a 8x3RGB simple matrix, and drawing 9 arranges the layered product 5 which consists of one side between cathode 3 and an anode plate 2, even if there are few electron hole transportation layers, and luminous layers and electron transport layers either (refer to drawing 3 and drawing 7 or drawing 4, and drawing 8). Both cathode and an anode plate are made to intersect perpendicularly in the shape of a matrix mutually, impress a signal level serially by the control circuits 15 and 14 with a built-in shift register, and they are constituted so that light may be emitted in the decussation location, while carrying out patterning to the shape of a stripe. Of course, the EL element of this configuration can be used also as picture reproducer as a display of an alphabetic character, a notation, etc. Moreover, the stripe-like pattern of cathode 3 and an anode plate 2 is arranged for every color of red (R), green (G), and blue

(B), and it becomes possible to constitute multicolor or all full color solid-state mold flat-panel displays.

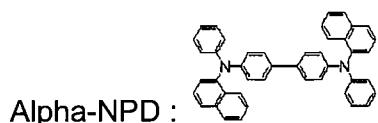
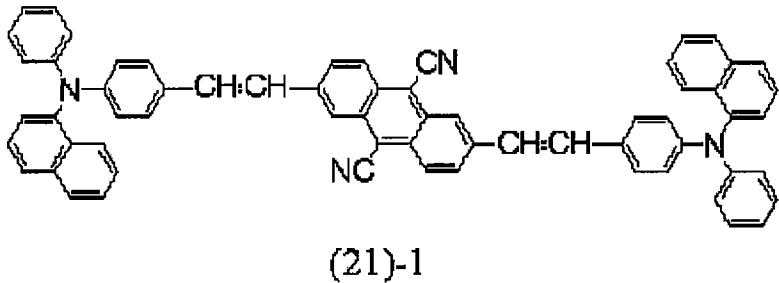
[0064]

[Example] Next, although this invention is concretely explained about an example, this invention is not limited to the following examples.

[0065] Example 1 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-1, and alpha-NPD (alpha-naphthylphenyl diamine) of the following structure expression as an electron hole transportability luminous layer.

[0066]

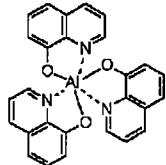
[Formula 15] Structure expression (21) -1 :



[0067] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, with the vacuum deposition method, it is the weight ratio 1:1, for example, alpha-NPD which is the above-mentioned structure-expression (21)-1 and an electron hole transportation ingredient under the vacuum of 10 - 4 or less Pa was formed as an electron hole transportation layer (******) in thickness of 50nm. The vacuum evaporationo rate was made respectively in 0.1nm/second.

[0068] Furthermore, Alq3 (tris (eight quinolinol) aluminum) of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 50nm, and the vacuum evaporationo rate was carried out in 0.2nm/second.

[0069]



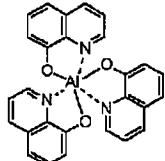
[Formula 16] Alq3:

[0070] The cascade screen of Mg and Ag was adopted as a cathode material,

[0067] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, with the vacuum deposition method, it is the weight ratio 1:1, for example, alpha-NPD which is the above-mentioned structure-expression (21)-1 and an electron hole transportation ingredient under the vacuum of 10 - 4 or less Pa was formed as an electron hole transportation layer (******) in thickness of 50nm. The vacuum evaporationo rate was made respectively in 0.1nm/second.

[0068] Furthermore, Alq3 (tris (eight quinolinol) aluminum) of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 50nm, and the vacuum evaporationo rate was carried out in 0.2nm/second.

[0069]



[Formula 16] Alq3:

[0070] The cascade screen of Mg and Ag was adopted as a cathode material,

and by vacuum evaporationo, it formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and although this also showed drawing 3 by the example 1, it produced **** organic electroluminescence devices.

[0071] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 1 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak near 680nm. The spectroscope which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 500 cd/m² was obtained by 8V.

[0072] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 250 hours until brightness was halved.

[0073] Example 2 this example is an example which produced the organic

electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of above-mentioned structure-expression (21)-1, and Alq3 as an electronic transportability luminous layer.

[0074] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in thickness of 50nm under the vacuum of 10 - 4 or less Pa with the vacuum deposition method. The vacuum evaporationo rate was carried out in 0.1nm/second.

[0075] Furthermore, Alq3 which is the amino styryl compound and electronic transportability ingredient of above-mentioned structure-expression (21)-1 was vapor-deposited in contact with the electron hole transportation layer by the weight ratio 1:1. The above-mentioned structure expression (21) Thickness of the electron transport layer (******) which consists of mixture of the amino styryl compound of -1 and Alq3 was also set to 50nm, and the vacuum evaporationo rate was made respectively in 0.2nm/second.

[0076] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporationo, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and produced the **** organic electroluminescence devices shown in drawing 3 by the example 2.

[0077] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 2 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 690nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 600 cd/m² was obtained by 8V.

[0078] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 200 hours until brightness was halved.

[0079] Example 3 this example is an example which produced the organic electroluminescence devices of double hetero structure among the amino styryl

compounds of a general formula [I], using the mixture of the amino styryl compound of above-mentioned structure-expression (21)-1, and Alq3 as an electronic transportability luminous layer.

[0080] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in thickness of 30nm under the vacuum of 10 - 4 or less Pa with the vacuum deposition method. The vacuum evaporationo rate was carried out in 0.2nm/second.

[0081] Furthermore, Alq3 which is the amino styryl compound and electronic transportability ingredient of above-mentioned structure-expression (21)-1 as a luminescent material was vapor-deposited in contact with the electron hole transportation layer by the weight ratio 1:1. The above-mentioned structure expression (21) Thickness of the luminous layer which consists of mixture of the amino styryl compound of -1 and Alq3 was also set to 30nm, and the vacuum evaporationo rate was made respectively in 0.2nm/second.

[0082] Furthermore, Alq3 of the above-mentioned structure expression was

vapor-deposited in contact with the luminous layer as an electronic transportability ingredient. Thickness of Alq3 was set to 30nm, and the vacuum evaporationo rate was carried out in 0.2nm/second.

[0083] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporationo, it formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and although this also showed drawing 4 by the example 3, it produced **** organic electroluminescence devices.

[0084] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 3 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

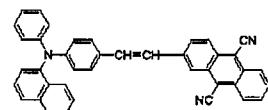
The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 690nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 800 cd/m² was obtained by 8V.

[0085] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 500 hours until brightness

was halved.

[0086] Example 4 this example is an example which produced the organic electroluminescence devices of double hetero structure among the general formula [I] or the amino styryl compound of [II], using the mixture of the amino styryl compound of following structure-expression (21)-8, and the amino styryl compound of above-mentioned structure-expression (21)-1 as a luminous layer.

[0087]



[Formula 17] Structure expression (21) -8 :

[0088] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in thickness of 30nm under the vacuum of 10⁻⁴ or less Pa with the vacuum deposition method. The vacuum evaporationo rate was carried out in 0.2nm/second.

[0089] Furthermore, the amino styryl compound of above-mentioned

structure-expression (21)-8 and the amino styryl compound of above-mentioned structure-expression (21)-1 were vapor-deposited in contact with the electron hole transportation layer by the weight ratio 1:3 as a luminescent material. The above-mentioned structure expression (21) Also setting to 30nm thickness of the luminous layer which consists of mixture of the amino styryl compound of -8, and the amino styryl compound of above-mentioned structure-expression (21)-1, in the vacuum evaporationo rate, the compound of above-mentioned structure-expression (21)-8 carried out the compound of 0.1nm /and above-mentioned structure-expression (21)-1 in 0.3nm/second a second.

[0090] Furthermore, Alq3 of the above-mentioned structure expression was vapor-deposited in contact with the luminous layer as an electronic transportability ingredient. Thickness of Alq3 was set to 30nm, and the vacuum evaporationo rate was carried out in 0.2nm/second.

[0091] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporationo, it formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and although this also showed drawing 4 by the example 4, it produced **** organic electroluminescence devices.

[0092] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 4 under

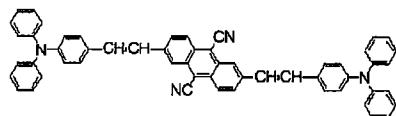
nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 710nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 300 cd/m² was obtained by 8V.

[0093] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 200 hours until brightness was halved.

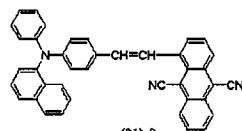
[0094] Example 5 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-9, and the amino styryl compound of following structure-expression (21)-2 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0095]



[Formula 18] Structure expression (21)-2 :

(21)-2



Structure expression (21)-9 :

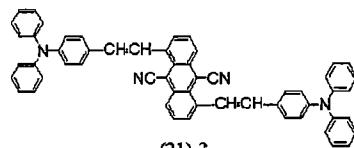
[0096] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 5 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 750nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 20 cd/m² was obtained by 8V.

[0097] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 20 cd/m², it was 100 hours until brightness was halved.

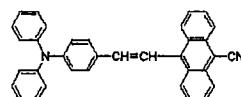
[0098] Example 6 this example is an example which produced the organic

electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-10, and the amino styryl compound of following structure-expression (21)-3 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0099]



[Formula 19] Structure expression (21)-3 :



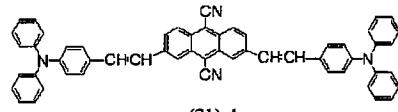
Structure expression (21)-10 :

[0100] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 6 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was orange, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 620nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 500 cd/m² was obtained by 8V.

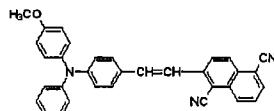
[0101] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 250 hours until brightness was halved.

[0102] Example 7 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-11, and the amino styryl compound of following structure-expression (21)-4 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0103]



[Formula 20] Structure expression (21) -4 :



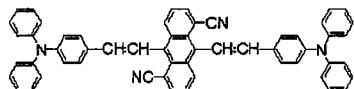
Structure expression (21) -11 :

[0104] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 7 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 660nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 250 cd/m² was obtained by 8V.

[0105] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 100 hours until brightness was halved.

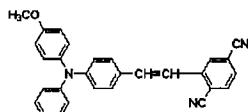
[0106] Example 8 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-13, and the amino styryl compound of following structure-expression (21)-5 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0107]



[Formula 21] Structure expression (21)-5 :

(21)-5



Structure expression (21)-13 :

(21)-13

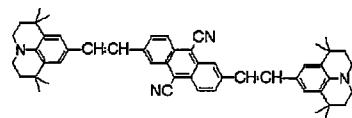
[0108] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 8 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was orange, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 615nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 320 cd/m² was obtained by 8V.

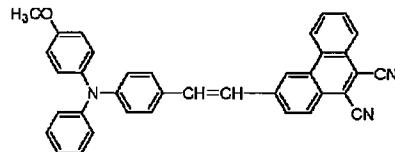
[0109] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 150 hours until brightness was halved.

[0110] Example 9 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-14, and the amino styryl compound of following structure-expression (21)-6 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0111]



[Formula 22] Structure expression (21) -6 :



Structure expression (21) -14 :

(21)-14

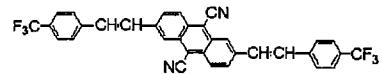
[0112] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 9 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 670nm. Moreover,

when the electrical-potential-difference-measurement of luminance was performed, the brightness of 230 cd/m² was obtained by 8V.

[0113] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 170 hours until brightness was halved.

[0114] Example 10 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-15, and the amino styryl compound of following structure-expression (21)-7 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0115]



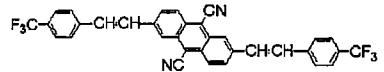
[Formula 23] Structure expression (21) -7 :

when the electrical-potential-difference-measurement of luminance was performed, the brightness of 230 cd/m² was obtained by 8V.

[0113] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 170 hours until brightness was halved.

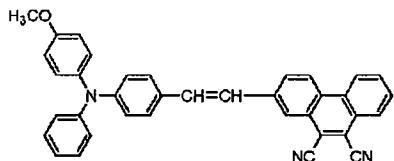
[0114] Example 10 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio 1:3) of the amino styryl compound of following structure-expression (21)-15, and the amino styryl compound of following structure-expression (21)-7 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0115]



[Formula 23] Structure expression (21)-7 :

(21)-7



Structure expression (21)-15 :

(21)-15

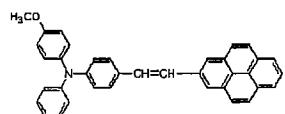
[0116] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 10 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 630nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 700 cd/m² was obtained by 8V.

[0117] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 300 hours until brightness was halved.

[0118] Example 11 this example is an example which produced the organic electroluminescence devices of terrorism structure to double among the general formula [I] or the amino styryl compound of [II], using the mixture (weight ratio

3:1) of the amino styryl compound of following structure-expression (21)-18, and the amino styryl compound of above-mentioned structure-expression (21)-1 as a luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 4.

[0119]



[Formula 24] Structure expression (21) -18 :

(21)-18

[0120] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 11 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

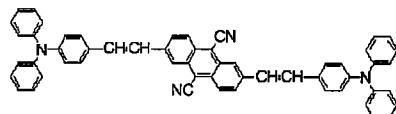
The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak in 640nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 450 cd/m² was obtained by 8V.

[0121] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 170 hours until brightness was

halved.

[0122] Example 12 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-2, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0123]



[Formula 25] Structure expression (21)-2 :

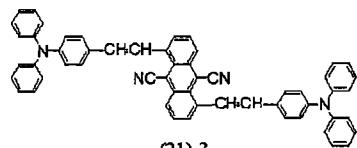
[0124] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 12 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 720nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 300 cd/m² was obtained by 8V.

[0125] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component

degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 220 hours until brightness was halved.

[0126] Example 13 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-3, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0127]



[Formula 26] Structure expression (21) -3 :

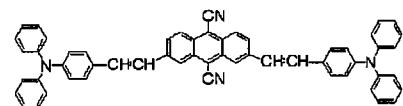
[0128] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 13 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 660nm. Moreover, when the electrical-potential-difference-measurement of

luminance was performed, the brightness of 500 cd/m² was obtained by 8V.

[0129] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 300 hours until brightness was halved.

[0130] Example 14 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-4, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0131]



[Formula 27] Structure expression (21)-4 :

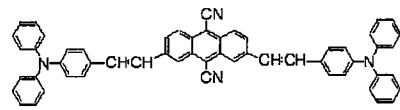
[0132] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 14 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

luminance was performed, the brightness of 500 cd/m² was obtained by 8V.

[0129] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 300 hours until brightness was halved.

[0130] Example 14 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-4, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0131]



[Formula 27] Structure expression (21) -4 :

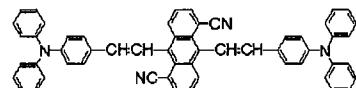
[0132] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 14 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 650nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 850 cd/m² was obtained by 8V.

[0133] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 200 hours until brightness was halved.

[0134] Example 15 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-5, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0135]



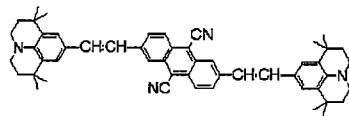
[Formula 28] Structure expression (21) -5 :

[0136] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 15 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 630nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 750 cd/m² was obtained by 8V.

[0137] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 300 hours until brightness was halved.

[0138] Example 16 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-6, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0139]



[Formula 29] Structure expression (21) -6 :

(21)-6

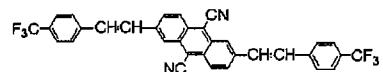
[0140] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 16 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 700nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 250 cd/m² was obtained by 8V.

[0141] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 200 hours until brightness was halved.

[0142] Example 17 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of following structure-expression (21)-7, and Alq3 as an electronic

transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0143]



[Formula 30] Structure expression (21) -7 : (21)-7

Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 17 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

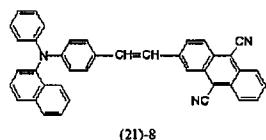
The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 665nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 800 cd/m² was obtained by 8V.

[0144] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 450 hours until brightness was halved.

[0145] Example 18 this example is an example which produced the organic

electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-8, and Alq₃ as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0146]



[Formula 31] Structure expression (21) -8 :

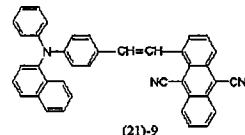
[0147] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 18 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 690nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 700 cd/m² was obtained by 8V.

[0148] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible

degradation by initial brightness 100 cd/m², it was 500 hours until brightness was halved.

[0149] Example 19 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-9, and Alq₃ as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0150]



[Formula 32] Structure expression (21)-9 :

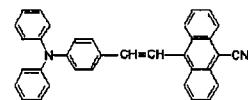
[0151] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 19 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 660nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 500 cd/m² was obtained by 8V.

[0152] After producing these organic electroluminescence devices, although it

was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 450 hours until brightness was halved.

[0153] Example 20 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-10, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0154]



[Formula 33] Structure expression (21) -10 :

(21)-10

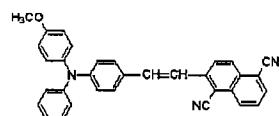
[0155] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 20 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was orange, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near

610nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 750 cd/m² was obtained by 8V.

[0156] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 500 hours until brightness was halved.

[0157] Example 21 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-11, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0158]



[Formula 34] Structure expression (21)-11 :

(21)-11

[0159] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 21 under

nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

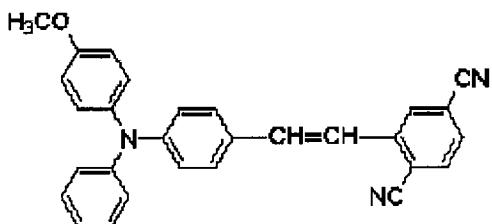
The luminescent color was orange, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 620nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 1200 cd/m² was obtained by 8V.

[0160] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 660 hours until brightness was halved.

[0161] Example 22 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-13, and Alq3 as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0162]

[Formula 35] Structure expression (21) -13 :



(21)-13

[0163] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 22 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

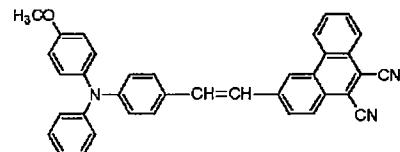
The luminescent color was orange, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 590nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 1500 cd/m² was obtained by 8V.

[0164] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 500 hours until brightness was halved.

[0165] Example 23 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl

compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-14, and Alq₃ as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0166]



[Formula 36] Structure expression (21) -14 :

(21)-14

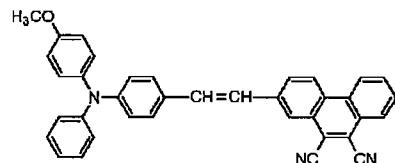
[0167] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 23 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 630nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 1100 cd/m² was obtained by 8V.

[0168] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible

degradation by initial brightness 100 cd/m², it was 500 hours until brightness was halved.

[0169] Example 24 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixture of the amino styryl compound of following structure-expression (21)-15, and Alq₃ as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0170]



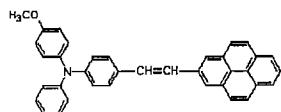
[Formula 37] Structure expression (21) -15 : (21)-15

[0171] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 24 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 1, it obtained the spectrum which has a luminescence peak near 630nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 700 cd/m² was obtained by 8V.

[0172] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 600 hours until brightness was halved.

[0173] Example 25 this example is an example which produced the organic electroluminescence devices of single hetero structure among the amino styryl compounds of a general formula [II], using the mixolimnion of the amino styryl compound of following structure-expression (21)-18, and Alq₃ as an electronic transportability luminous layer. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 2.

[0174]



(21)-18

[Formula 38] Structure expression (21) -18 :

[0175] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 25 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was orange, and as a result of performing spectrometry

like an example 1, it obtained the spectrum which has a luminescence peak near 580nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 900 cd/m² was obtained by 8V.

[0176] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 450 hours until brightness was halved.

[0177] Example 26 this example is an example which produced the **** organic electroluminescence devices shown in drawing 7 among the amino styryl compounds of a general formula [I], using the amino styryl compound of above-mentioned structure-expression (21)-1, and the mixture of alpha-NPD (alpha-naphthylphenyl diamine) of the above-mentioned structure expression as an electron hole transportability luminous layer.

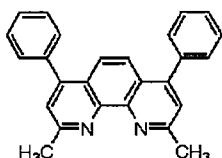
[0178] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, with vacuum evaporation technique, it is

the weight ratio 1:1, for example, alpha-NPD which is the amino styryl compound and electron hole transportation ingredient of above-mentioned structure-expression (21)-1 under the vacuum of 10 - 4 or less Pa was formed as an electron hole transportation layer (******) in thickness of 50nm. The vacuum evaporationo rate was made respectively in 0.1nm/second.

[0179] Furthermore, the bathocuproine of the following structure expression was vapor-deposited in contact with the electron hole transportation layer as a hole blocking layer ingredient. The thickness of this hole blocking layer that consists of bathocuproine set to 15nm, and the vacuum evaporationo rate was carried out in 0.1nm/second.

[0180] Furthermore, Alq3 (tris (eight quinolinol) aluminum) of the above-mentioned structure expression was vapor-deposited in contact with the hole blocking layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 50nm, and the vacuum evaporationo rate was carried out in 0.2nm/second.

[0181]



[Formula 39] Bathocuproine :

[0182] The cascade screen of Mg and Ag was adopted as a cathode material,

and by vacuum evaporationo, this was also formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and produced the **** organic electroluminescence devices shown in drawing 7 by the example 26.

[0183] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 26 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was red, and as a result of performing spectrometry, it obtained the spectrum which has a luminescence peak near 720nm. The spectroscope which used the photodiode array by the Otsuka electronic company as the detector was used for spectrometry. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 250 cd/m² was obtained by 8V.

[0184] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 200 hours until brightness was halved.

[0185] Example 27 this example is an example which produced the **** organic

electroluminescence devices shown in drawing 8 among the amino styryl compounds of a general formula [I], using the mixture of the amino styryl compound of above-mentioned structure-expression (21)-1, and Alq3 as an electronic transportability luminous layer.

[0186] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in thickness of 30nm under the vacuum of 10 - 4 or less Pa with the vacuum deposition method. The vacuum evaporationo rate was carried out in 0.2nm/second.

[0187] Furthermore, Alq3 which is the amino styryl compound and electronic transportability ingredient of above-mentioned structure-expression (21)-1 as a luminescent material was vapor-deposited in contact with the electron hole transportation layer by the weight ratio 1:1. The above-mentioned structure expression (21) Thickness of the luminous layer which consists of mixture of the amino styryl compound of -1 and Alq3 was also set to 30nm, and the vacuum evaporationo rate was made respectively in 0.2nm/second.

[0188] Furthermore, the bathocuproine of the above-mentioned structure expression was vapor-deposited in contact with the luminous layer as a hole blocking layer. The thickness of this hole blocking layer that consists of bathocuproine set to 15nm, and the vacuum evaporationo rate was carried out in 0.1nm/second.

[0189] Furthermore, Alq3 of the above-mentioned structure expression was vapor-deposited in contact with the hole blocking layer as an electron transport layer ingredient. Thickness of this electron transport layer that consists of Alq3 was also set to 30nm, and the vacuum evaporationo rate was carried out in 0.2nm/second.

[0190] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporationo, it formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and although this also showed drawing 8 by the example 27, it produced **** organic electroluminescence devices.

[0191] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 27 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near

720nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 220 cd/m² was obtained by 8V.

[0192] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 350 hours until brightness was halved.

[0193] Example 28 this example is an example which produced the **** organic electroluminescence devices shown in drawing 8 among the general formula [I] or the amino styryl compound of [II], using the mixture of the amino styryl compound of above-mentioned structure-expression (21)-8, and the amino styryl compound of above-mentioned structure-expression (21)-1 as a luminous layer.

[0194] First, the 30mmx30mm glass substrate with which the anode plate which consists of ITO with a thickness of 100nm was formed on one front face into the vacuum evaporation system was set. The substrate was approached, the metal mask which has two or more 2.0mmx2.0mm unit openings as a vacuum evaporationo mask has been arranged, and alpha-NPD of the above-mentioned structure expression was formed as an electron hole transportation layer in thickness of 30nm under the vacuum of 10 - 4 or less Pa with the vacuum

deposition method. The vacuum evaporationo rate was carried out in 0.2nm/second.

[0195] Furthermore, the amino styryl compound of above-mentioned structure-expression (21)-8 and the amino styryl compound of above-mentioned structure-expression (21)-1 were vapor-deposited in contact with the electron hole transportation layer by the weight ratio 1:3 as a luminescent material. The above-mentioned structure expression (21) Also setting to 30nm thickness of the luminous layer which consists of mixture of the amino styryl compound of -8, and the amino styryl compound of above-mentioned structure-expression (21)-1, in the vacuum evaporationo rate, the compound of above-mentioned structure-expression (21)-8 carried out the compound of 0.1nm /and above-mentioned structure-expression (21)-1 in 0.3nm/second a second.

[0196] Furthermore, the bathocuproine of the above-mentioned structure expression was vapor-deposited in contact with the luminous layer as a hole blocking layer. The thickness of this hole blocking layer that consists of bathocuproine set to 15nm, and the vacuum evaporationo rate was carried out in 0.1nm/second.

[0197] Furthermore, Alq3 of the above-mentioned structure expression was vapor-deposited in contact with the luminous layer as an electronic transportability ingredient. Thickness of Alq3 was set to 30nm, and the vacuum

evaporationo rate was carried out in 0.2nm/second.

[0198] The cascade screen of Mg and Ag was adopted as a cathode material, and by vacuum evaporationo, it formed in the thickness of 50nm (Mg film) and 150nm (Ag film) as vacuum evaporationo rate 1nm/a second, and although this also showed drawing 8 by the example 28, it produced **** organic electroluminescence devices.

[0199] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 28 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near 710nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 250 cd/m² was obtained by 8V.

[0200] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 50 cd/m², it was 330 hours until brightness was halved.

[0201] Example 29 this example is an example which produced the organic

electroluminescence devices which used the mixture (weight ratio 1:3) of the amino styryl compound of above-mentioned structure-expression (21)-9, and the amino styryl compound of above-mentioned structure-expression (21)-2 as an electronic transportability luminous layer among the general formula [I] or the above-mentioned amino styryl compound of [II]. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 28.

[0202] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 29 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near 750nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 15 cd/m² was obtained by 8V.

[0203] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 20 cd/m², it was 150 hours until brightness was halved.

[0204] Example 30 this example is an example which produced the organic electroluminescence devices which used the mixture (weight ratio 1:3) of the amino styryl compound of above-mentioned structure-expression (21)-10, and the amino styryl compound of above-mentioned structure-expression (21)-3 as an electronic transportability luminous layer among the general formula [I] or the above-mentioned amino styryl compound of [II]. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 28.

[0205] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 30 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated.

The luminescent color was orange, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near 620nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 450 cd/m² was obtained by 8V.

[0206] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 350 hours until brightness

was halved.

[0207] Example 31 this example is an example which produced the organic electroluminescence devices which used the mixture (weight ratio 1:3) of the amino styryl compound of above-mentioned structure-expression (21)-11, and the amino styryl compound of above-mentioned structure-expression (21)-4 as an electronic transportability luminous layer among the general formula [I] or the above-mentioned amino styryl compound of [II]. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 28.

[0208] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 31 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near 660nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 200 cd/m² was obtained by 8V.

[0209] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible

degradation by initial brightness 100 cd/m², it was 150 hours until brightness was halved.

[0210] Example 32 this example is an example which produced the organic electroluminescence devices which used the mixture (weight ratio 1:3) of the amino styryl compound of above-mentioned structure-expression (21)-13, and the amino styryl compound of above-mentioned structure-expression (21)-5 as an electronic transportability luminous layer among the general formula [I] or the above-mentioned amino styryl compound of [II]. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 28.

[0211] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 32 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was orange, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near 615nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 280 cd/m² was obtained by 8V.

[0212] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component degradation was not observed. Moreover, when energizing a current value

uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 250 hours until brightness was halved.

[0213] Example 33 this example is an example which produced the organic electroluminescence devices which used the mixture (weight ratio 1:3) of the amino styryl compound of above-mentioned structure-expression (21)-14, and the amino styryl compound of above-mentioned structure-expression (21)-6 as an electronic transportability luminous layer among the general formula [I] or the above-mentioned amino styryl compound of [II]. Layer structure and the forming-membranes method produced organic electroluminescence devices based on the example 28.

[0214] Thus, forward bias direct current voltage was applied to the organic electroluminescence devices of the produced example 33 under nitrogen-gas-atmosphere mind, and the luminescence property was evaluated. The luminescent color was red, and as a result of performing spectrometry like an example 26, it obtained the spectrum which has a luminescence peak near 670nm. Moreover, when the electrical-potential-difference-measurement of luminance was performed, the brightness of 210 cd/m² was obtained by 8V.

[0215] After producing these organic electroluminescence devices, although it was left for one month under nitrogen-gas-atmosphere mind, component

degradation was not observed. Moreover, when energizing a current value uniformly, carrying out continuation luminescence and carrying out forcible degradation by initial brightness 100 cd/m², it was 220 hours until brightness was halved.

[0216]

[Function and Effect of the Invention] Since it consists of mixture with which the at least 1 section of said organic layer contained at least one sort of an amino styryl compound expressed with said general formula [I] or [II] in the organic electroluminescence devices by which the organic layer which has a luminescence field is prepared between an anode plate and cathode according to the organic electroluminescence devices of this invention, it becomes possible to offer the organic electroluminescence devices which have stable red or red Mr. luminescence by high brightness.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the important section outline sectional view of an example of the organic electroluminescence devices based on this invention.

[Drawing 2] It is the important section outline sectional view of other examples of **** organic electroluminescence devices.

[Drawing 3] It is the important section outline sectional view of other examples of **** organic electroluminescence devices.

[Drawing 4] It is the important section outline sectional view of other examples of **** organic electroluminescence devices.

[Drawing 5] It is the important section outline sectional view of other examples of **** organic electroluminescence devices.

[Drawing 6] It is the important section outline sectional view of other examples of **** organic electroluminescence devices.

[Drawing 7] It is the important section outline sectional view of other examples of **** organic electroluminescence devices.

[Drawing 8] It is the important section outline sectional view of the example of further others of **** organic electroluminescence devices.

[Drawing 9] It is the block diagram of the full color flat-surface display using **** organic electroluminescence devices.

[Description of Notations]

1 [-- An organic layer, 6 / -- An electron hole transportation layer, 7 / -- An electron transport layer, 8 / -- A power source, 10 / -- An electron hole transportation layer, 11 / -- A luminous layer, 12 / -- An electron transport layer,

14 / -- A luminance-signal circuit, 15 / -- A control circuit, 20 / -- Luminescence light, 21 / -- A hole (electron hole) blocking layer, A, B, C, D / -- Organic electroluminescence devices] -- A substrate, 2 -- transparent electrode (anode plate), 3 -- Cathode, 4 -- A protective coat, 5, 5a, 5b